MUSIC SUPERVISORS'

NATIONAL CONFERENCE

1917

JOURNAL OF PROCEEDINGS

OF THE

TENTH

ANNUAL MEETING

OF THE

Music Supervisors' National Conference

HELD AT

GRAND RAPIDS, MICHIGAN

MARCH 19-23

1917

Copies of this and preceding volumes may be purchased at $1.00 a copy from James McIlroy, Jr., Treas..

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Constitution and By-Laws

(Note: In order to avoid unnecessary repetition, there is printed in this place the complete report of the committee on the revision of the Constitution and By Laws presented at the Grand Rapids Meeting. All the material which at present is in force can easily be picked out by noting the side-headings, such as "no change" or "according to the present Constitution". The original Constitution and By-Laws were adopted at a Meeting held in Cincinnati, Ohio, May 6, 1910. The revisions here proposed will be acted upon at the 1918 Meeting. Until that time the original Constitution stands. P. W. D.)

Article I. No change

ARTICLE I.—NAME.

This organization shall be known as the Music Supervisors' National Conference.

Article II. No change

ARTICLE II.—OBJECT.

Its object shall be mutual helpfulness and the promotion of good music through the instrumentality of the Public Schools.

Article III. Sec. 1. No change

ARTICLE III.—MEMBERSHIP.

Sec. 1. Membership shall be Active, Associate and Honorary.

According to the present Constitution.

Sec. 2. Any person actively interested in Public School music may become an active member of the Conference upon the payment of the prescribed dues.

Proposed change in Sec. 2 of Article III.

Sec. 2. Any person actively interested in Public School Music, may become an Active Member of the Conference, upon the payment of the prescribed dues. Active members whose dues are fully paid shall have the privilege of voting and holding office.

According to the present Constitution.

Sec. 3. Any person not actively interested in Public School music may become an Associate Member upon the payment of the prescribed dues. Associate members shall have the privilege of attending all meetings, of taking part in discussions, but will not have a vote nor receive a printed copy of the proceedings.

Proposed change in Sec. 3 of Article III.

Sec. 3. Any person interested in Public School Music may become an Associate Member of the Conference upon payment of the prescribed dues. Associate members shall have the privilege of attending all meetings and of taking part in discussions, but they shall not have a vote nor hold office, and they are not entitled to a printed copy of the Proceedings.

According to the present Constitution.

Sec. 4. Honorary members shall consist of persons of distinguished positions, or of unusual attainment who manifest a friendly interest in our work. The names of such persons shall be presented by an active member at the regular business meeting, and upon a majority vote of the Conference, shall be enrolled as Honorary members.

Proposed change in Sec. 4 of Article III.

Sec. 4. Honorary membership shall consist of persons of distinguished positions, or of unusual attainment who manifest a friendly interest in Public School Music work. The names of such persons shall be presented by an active member at the Annual Business Meeting, and upon a majority vote of the Conference shall be enrolled as honorary members. Honorary members shall enjoy all the privileges of the Conference, except voting and holding office and shall not be required to pay dues.

According to the present Constitution.

ARTICLE IV.—DUES.

Sec. 1. The dues for Active Members shall be $2.50 for the first year and $1.50 annually thereafter. If the annual dues are not paid the membership will lapse.

Proposed change in Sec. 1 of Article IV.

ARTICLE IV.—DUES.

Sec. 1. The dues for Active Members shall be $2.50 for the first year and $1.50 annually thereafter. Dues are payable, for the current year, on and after January 1st; if the dues for the current year are not paid by December 31st, active membership lapses, and such a person desiring to be re-instated, may exercise the option of renewing membership by paying all arrears and receiving the published Proceedings of the intervening years, or of becoming an active member, on the same terms as new members.

According to present Constitution. No change

Sec. 2. The dues for Associate Members shall be $1.00 annually.

According to present Constitution.

Sec. 3. There shall be no dues for honorary membership.

Proposed change in Sec. 3 of Article IV.

Sec. 3. No person shall be entitled to the privileges of active or associate membership until dues for the current year shall have been paid.

ARTICLE V.—OFFICERS.

According to present Constitution.

Sec. 1. The officers of this Conference shall consist of a President, Vice-President, Secretary, Treasurer, and a Board of Directors.

Proposed change in Sec. 1 of Article V.

Sec. 1. The officers of this Conference shall consist of a President, 1st. Vice President, 2nd. Vice President, Secretary, Treasurer, Auditor and Board of Directors, and these officers shall constitute the Executive Committee of the Conference.

According to present Constitution.

Sec. 2. The Board of Directors shall consist of five members elected for the first time for terms of five, four, three, two and one year thereafter. The member whose term of office next expires shall be the chairman.

Proposed change in Sec. 2 of Article V.

Sec. 2. The term of office for President, 1st. Vice President, 2nd. Vice-President, Secretary, Treasurer and Auditor shall be one year, or until their successors are duly elected. With the exception of the Treasurer and 2nd. Vice-President, none of the above mentioned officers shall hold the same office for more than two consecutive years.

Proposed as Sec. 3 of Article V.

Sec. 3. The Board of Directors shall consist of 5 members elected for the first time for a period of 5, 4, 3, 2 and 1 year respectively; at each annual meeting thereafter, one Director shall be elected for a term of 5 years to fill the place made vacant by the retiring member. The member whose term of office next expires shall be the Chairman of the Board of Directors for that year.

According to the present Constitution.

Article VI.—Elections.

These officers shall be nominated by a committee consisting of seven members appointed by the President. This Committee shall be appointed at the second session of the annual meeting of the Conference. Said committee shall submit its report at the regular business meeting. A majority of all votes cast is required to elect.

Proposed change in Sec. 1 of Article VI.

Sec. I. The President, 1st Vice President, 2nd Vice President, Secretary, Treasurer, Auditor and one member of the Board of Directors, shall be nominated by a Committee consisting of 7 members appointed by the President. This Committee shall be appointed at the second session of the Annual Meeting of the Conference, and shall submit its report at the Annual Business Meeting.

Proposed as Sec. 2 of Article VI.

Sec. 2. The election of officers shall occur at the Annual Business Meeting of the Conference. A majority of all votes cast is required to elect.

According to present Constitution.

Article VII.—Duties of Officers.

Sec. 1. It shall be the duty of the President to arrange the program, to preside at all meetings and to appoint committees.

According to present Constittuion.

Article IX.—Amendments.

Sec. 1. Amendments to the Constitution may be made at any regular business meeting of the Confer-

ence, provided written notice of such proposed amendment shall have been presented at the preceding regular annual business meeting.

Sec. 2. A two-thirds vote of the members of the Conference present and voting, shall be necessary for the adoption of such amendments.

Proposed as Article VIII of the Constitution.

ARTICLE VIII AMENDMENTS.

The Constitution and By-Laws may be altered or amended by a two-thirds vote at any Annual Business meeting of the Conference, providing formal notice of such contemplated action shall have been given the active members at least 60 days before it is acted upon.

According to the present Constitution.

ARTICLE VIII.—MEETINGS.

Meetings shall be held annually between the dates of March 15th and May 15th, at the discretion of the Board of Directors. The regular business meeting of the Conference shall be held on the day next preceding the closing day of the Conference.

Proposed as Article VII of the Constitution.

ARTICLE VII.—MEETINGS.

Sec. 1. Meetings shall be held annually between the dates of February 15th and May 15th, at the discretion of the Executive Committee. The Annual Business Meeting shall be held on the day next preceding the closing day of the Conference. Twenty active members shall constitute a quorum for the transaction of business at the Annual Business Meeting.

Sec. 2. The Executive Committee shall meet at the call of the President, or at the call of the Secretary, when the Secretary is requested to do so, by not less than three (3) of the members of the Executive Committee. A quorum of five (5) members of the Executive Committee is required for the transaction of business.

Calendar of Meetings

1907—Keokuk, Iowa. (Organized)
Frances E. Clark, Chairman.
P. C. Hayden, Secretary.

1909—Indianapolis, Indiana.
P. C. Hayden, President.
Stella R. Root, Secretary.

1910—Cincinnati, Ohio.
E. L. Coburn, President.
Stella R. Root, Secretary.

1911—Detroit, Michigan.
E. B. Birge, President.
Clyde E. Foster, Secretary.

1912—St. Louis, Missouri.
Chas. A. Fullerton, President.
M. Ethel Hudson, Secretary.

1913—Rochester, New York.
Henrietta G. Baker, President.
Helen Cook, Secretary.

1914—Minneapolis, Minnestota.
Mrs. Elizabeth Casterton, President.
Miss May E. Kimberly, Secretary.

1915—Pittsburgh, Pennsylvania.
Arthur W. Mason, President.
Chas. H. Miller, Secretary.

1916—Lincoln, Nebraska.
Will Earhart, President.
Agnes Benson, Secretary.

1917—Grand Rapids, Michigan.
Peter W. Dykema, President.
Julia E. Crane, Secretary.

1918—Place of meeting undecided at time of printing Proceedings.
C. H. Miller, President.
Ella M. Brownell, Secretary.

Officers

OFFICERS FOR 1916—1917.

President—MR. PETER W. DYKEMA, Madison, Wis.
Vice-President—MR. CHAS. H. MILLER, Lincoln, Neb.
Secretary—MISS JULIA E. CRANE, Potsdam, N. Y.
Treasurer—MR. JAMES E. MCILROY, McKeesport, Pa.

BOARD OF DIRECTORS.

MR. OSBOURNE MCCONATHY, Chairman, Evanston, Ill.
MR. HOLLIS DANN, Ithaca, N. Y.
MISS ELSIE M. SHAWE, St. Paul, Minn.
MR. KARL W. GEHRKENS, Oberlin, Ohio.
MISS ALICE C. INSKEEP, Cedar Rapids, Ia.

OFFICERS FOR 1917—1918.

President—MR. C. H. MILLER, Lincoln, Neb.
Vice-President—MR. OSBOURNE MCCONATHY, Evanston Ill.
Secretary—MISS ELLA M. BROWNELL, St. Johnsbury, Vt.
Treasurer—MR. JAMES E. MCILROY, McKeesport, Pa.
Chairman Committee on Publicity, MR. P. W. DYKEMA, Madison, Wis.

BOARD OF DIRECTORS

MR. HOLLIS DANN, Ithaca, New York, Chairman.
MISS ELSIE M. SHAWE, St. Paul, Minnesota.
MISS ALICE INSKEEP, Cedar Rapids, Iowa.
MR. KARL W. GEHRKENS, Oberlin, Ohio.
MR. J. W. BEATTIE, Grand Rapids, Michigan.

USIC SUPERVISORS' NATIONAL CONFERENCE

An organization working principally through the Schools for the promotion of music as an educational and social factor in American life.

Program—Tenth Meeting

Grand Rapids, Michigan

TIME OF MEETINGS:—9:00 to 11:30 A. M.; 1:30 to 4:00 P. M.

MONDAY, MARCH 19, 1917

9:00 A. M.—Visiting Local Work, Grades and High School (Descriptive
1:30 P. M.—schedules and guides will be provided at the headquarters).

8:00 P. M.—Armory—Local concert, vocal and instrumental, by high school groups. *The Deacon's Masterpiece,* a cantata for mixed voices by Percy E. Fletcher (composer of *The Walrus and the Carpenter*) will be the main number.

TUESDAY

9:00 A. M.—Visiting classes. In five buildings, these will be taught by the local supervisor and his assistants. In other buildings, some or all of the following visiting supervisors will have classes: Eleanor Smith, W. A. White, Osbourne McConathy, Catherine Strouse, Agnes M. Fryberger, Geo. O. Bowen, J. Beach Cragun, Margaret M. Streeter, T. P. Giddings, Lillian McCracken. There will be three periods of 25 minutes each followed by a recess of 15 minutes for discussion. After the recess the same teacher will take the same three classes for additional periods of 20 minutes each.

In order to avoid congestion, admission to these various demonstrations will be by ticket only—a fixed number being provided which may be obtained at the headquarters. Separate tickets should be requested for the two sessions into which this morning's work will be divided. A schedule of the grades and buildings in which the teaching will be done and a general statement of the work to be attempted will be posted.

11:45 A. M.—Central, Union, and South High Schools. Short assembly exercises followed by lunch.

1:30 P. M.—Central High School: Public Meeting: Address of Welcome by Superintendent W. A. Greeson; President's address by P. W. Dykema, Madison, Wis., on "Delivering the Message of Music"; Address by Percival Chubb, St. Louis, Mo., on "Music as a Folk Art." Community Singing. Selections by Grand Rapids Woodwind Quintet.

4:00 P. M.—Central High School. Rehearsal of Sopranos for Supervisors' Concert.

6:00 P. M.—Association of Commerce Building—Informal Banquet ($1.00 per plate).

8:30 P. M.—Central High School—By courtesy of Grand Rapids Teachers' Club, Concert of Folk Songs by the Misses Dorothy, Rosalind, and Cynthia Fuller, in partial exemplification of Mr. Chubb's address.

WEDNESDAY

8:30 A. M.—Banquet Hall. Rehearsal of Altos with Father Finn.

9:00 A. M.—Central High School—Topic: Instrumental Music in the Schools—J. W. Beattie (Michigan), with illustrations furnished by pupils from his schools; Glenn H. Woods (California), R. C. Sloane (Indiana); Anton Embs (Indiana); Arthur J. Abbott (New York). Time limits: The leader 50 minutes; the others 10 minutes each.

11:30 A. M.—Banquet Hall. Rehearsal of Basses with Father Finn.

12:00 Noon—Grill Room. Luncheon group of officers and advisory council.

1:30 P. M.—Armory. Address by Father W. J. Finn, Chicago, on "Music and Morality" (a psychological phase).

3:00 P. M.—Armory. Vocal and instrumental concert by younger children. One part of the program will be "Walrus and Carpenter" sung by 1,000 sixth grade children accompanied by grade school orchestra.

4:00 P. M.—Armory. Rehearsal of Tenors with Father Finn.

6:00 P. M.—Formal banquet ($1.50 a plate) and social gathering: Three or four short talks followed by "stunts" and "mixer": for conference members only.

THURSDAY

9:00 A. M.—"The Education of the Supervisor"—Supt. John H. Francis (Columbus, Ohio); Supt. A. C. Barker, Oakland, California; Hamlin E. Cogswell (District of Columbia); C. H. Farnsworth (New York); Caroline V. Smith (Minnesota). Time Limit: Leader, 30 minutes, each of the others, 10 minutes.

10:15 A. M.—Address: "The Photography of Sound Waves" (Illustrated on the stereopticon screen)—Professor Dayton C. Miller, Cleveland, Ohio.

11:00 A. M.—Business meeting: All matters to be discussed should be presented to the Secretary by 9:00 P. M. Wednesday.

1:30 P. M.—Address: "Standards, tests and measurements in Music Teaching"—Professor Raymond H. Stetson, Oberlin, O.

2:15 P.M.—Round Table Discussions.

1. The Voice of the Boy—with special reference to the four years from age 11 on—Chairman, Father W. J. Finn, Chicago, Illinois, Secretary, Caroline B. Bourgard, Louisville, Ky.
2. Band and Orchestra Material—Discussion will start with a consideration of the lists published during the

year in the Music Supervisors' Journal. Chairman, Mr. Will Earhart, Pittsburgh, Pa., Secretary, Miss Ada E. Bicking, Evansville, Ind.

3. Material for Public Performances by Grade Children—being a discussion of specific works along the general lines laid down by Irving W. Jones in his address at the Lincoln Conference (see 1916 Book of Proceedings). Chairman, Hollis Dann, Ithaca, New York, Secretary, Juliet McCune, Omaha, Neb.
4. The School Survey. Chairman, J. Beach Cragun, Chicago, Ill., Secretary, Ella M. Brownell, St. Johnsburg, Vt.
5. Harmony Classes in the High School, Chairman, Carolyn A. Alchin, Los Angeles, Cal., Secretary, Augustus Zanzig, New York.
6. Problems in Education of the Supervisor, Chairman C. A. Fullerton, Cedar Falls, Ia., Secretary, Clyde Foster, Ypsilanti, Mich.
7. Music Appreciation in the Grades, Chairman, Agnes M. Fryberger, Minneapolis, Minn., Secretary, Ernest G. Hesser, Bowling Green, O.

3:30 P. M.—Armory—Final rehearsal for supervisors' concert.

6:00 P. M.—Informal Banquet ($1.00 a plate).

8:30 P. M.—Supervisors' concert consisting of two parts:

(a) Community Singing by supervisors and audience, led by Mr. Harry H. Barnhart of New York.

(b) Program by the supervisors led by Father W. J. Finn of Chicago.

(Note: The material for the supervisors' concert has been collected into a 25 cent pamphlet by C. C. Birchard Co., Boston, Mass.)

10:00 P. M.—Armory—Conference Photograph. (Be sure to get an index number. Write your name on it.)

FRIDAY

9:00 A. M.—"The Extension of Music into Schools which at Present Have Little or None"—Frank A. Beach, Kansas; Paul E. Beck, Pennsylvania; Milton Cook, Tennessee; S. S. Myers, Kentucky. Demonstrations of work carried on in rural schools in the neighborhood of Grand Rapids. Time limits: Leader, 20 minutes; others, 10 minutes each.

11:00 A. M.—Business meeting: All matters to be discussed should be presented to the Secretary by 9:00 P. M. Thursday.

1:30 P. M.—Topic—"How to Cause the Present General Interest in Community Music to Develop into Permanent Art Manifestations"—Harry H. Barnhart, New York, Frances F. Brundage, Chicago, Henrietta Baker Low, Baltimore, George Colburn, Winona, Minn. Time limits: Leader, 30 minutes; others 15 minutes each.

3:45 P. M.—Meeting closes.

4:15 P. M.—Special train leaves for Chicago, arriving there at 8:50 P. M.

A Review of the Conference

A SYMPOSIUM.

(Note: In lieu of a formal review of the Conference, the following typical expressions of appreciation are presented. Full details of the program printed on the proceding pages, which was carried out almost exactly as announced, will be found in the complete report which follows.)

FROM OUR HOST

MR. J. W. BEATTIE, supervisor of music, Grand Rapids, Mich.

The National Conference of Music Supervisors was a very happy event from our local standpoint and one which will not soon be forgotten. The fact that teachers, principals, administrative authorities and everybody connected with our schools were willing to cooperate in making Grand Rapids' part in the Conference a success, is the thing which gives me the most satisfaction. And the inspiration which our children received, the professional spirit engendered among the teachers in the music department through all of them having a part in preparing for and entertaining the Conference and the greatly strengthened belief in the importance of music among our principals, school authorities and citizens has more than justified my faith in the value of the Conference to any city where it is held.

The experience of preparing for the Conference and then having it pass off so smoothly has left a profound and I believe a lasting impression upon our community.

From my own personal standpoint, the opportunity to play host to so large and representative a group of supervisors, was a source of great pleasure. I wish you might be prevailed upon to pay us another visit.

FROM THE LOCAL SUPERINTENDENT OF SCHOOLS

SUPERINTENDENT W. A. GREESON, Grand Rapids, Mich.

I fear that I cannot adequately express my feelings on the question of the Conference of Music Supervisors held in Grand Rapids March 19-23. Personally, it was a great inspiration to me and fortified me in the opinion which I have long held that music is of the utmost importance in an educational system. The great problem that confronts educators today is the matter of cooperation between the school and the home, and in this important question, music must occupy an important place.

The Conference of Music Supervisors has made it possible to continue the work in music in Grand Rapids with even greater enthusiasm then we have ever had before. The schools have felt the inspiration coming from the conference, and what is quite as important, the same inspiration is felt

by the Board of Education and by the public so that we have had no trouble to get all the money we have asked for for the department of music in the public schools.

FROM ONE OF OUR PRINCIPAL SPEAKERS

MR. PERCIVAL CHUBB, St. Louis, Mo.

I liked your Grand Rapids Convention because it was alive, because music itself was there and not mere talk about music, and because there was a happy "camaraderie" among the hundreds who were present. Then the receptivity and open-mindedness were stimulating and encouraging. I was struck by the readiness to take criticism seriously and kindly. The singing of America at the great meeting on the Tuesday afternoon was thrilling,—as fine as anything of the kind I have ever heard. And the songs with which you punctuated your programs and the courses at your banquets were refreshing and exhilarating. If only the gloom of the average Teachers' Institute meeting could be relieved in the same way, how salutary it would be! The teachers would be happily involved in the presentation of the arts instead of marking time on the eternal treadmill of methodology. I thoroughly enjoyed the experience.

FROM A VISITING SUPERINTENDENT OF SCHOOLS

SUPERINTENDENT A. C. BARKER, Oakland, California.

In answer to your request for my impressions of the Grand Rapids meeting, it is impossible for me to give you an extended account, but it is a distinct pleasure to make an informal comment upon it. I shall always esteem it a privilege to have been able to be present at the Annual Conference of Music Supervisors. During the past thirty years, I have attended many educational conventions, local, state and national, both East and West, but this Grand Rapids meeting was the best and most inspiring of them all. The fact that the music supervisors are willing to travel from the remote parts of the country to this meeting at their own expense indicates a high degree of professional zeal. A visitor could hardly escape the spirit of contagious enthusiasm of those who are striving frequently against the indifference of boards of education and superintendents to realize the possibilities of their profession. I predict that, during the next ten years, music will receive in our school systems the recognition from the public that it deserves. What other subject offers equal social, cultural, and vocational values?

FROM ONE OF OUR THOUGHTFUL MEMBERS WHO HAS ATTENDED MANY CONFERENCES

PROFESSOR CHARLES H. FARNSWORTH, Teachers College, New York City.

It is not easy to sum up the whole significance of the attendance at a convention such as the Grand Rapids meeting in March. This difficulty is not because striking and interesting experiences do not come to mind, but because the experiences were so many and various that it is difficult to sum them all together and state what the value of it as a whole is.

Such interesting features as the address by Mr. Chubb and that by Superintendent Francis throw light on the work of the music supervisor from an angle outside of that usually given in such conventions. At the same time, these were authoritative and showed sympathetic appreciation of both educational and musical problems.

Other features were the stimulation of the imagination on the scientific side, done by means of Professor Miller's wonderful apparatus; the music of landscape that so fascinated the convention at the banquet by means of the color slides of great Portland scenic road; not to speak of, perhaps, the most valuable stimulation that came from the rehearsals and program conducted by Father Finn; the wonderfully fine impression of harmony and good fellowship between professional people that voiced itself in the singing at the three dinners together; and the fine opportunity for both asking and getting answers to professional and musical problems that the opportunity for meeting so many workers along music teaching lines afforded.

Granting the worth of such valuable features, I think almost everyone will agree that the best part of the convention is something difficult to describe and can be compared only to a gaining in feeling and inspiration in one's work that immediately shows itself in every detail of one's professional activity.

I was greatly interested in talking to two young supervisors who had never before attended such a meeting. Over and over they said, "We shall be sure to go to the next one, we never realized what it meant." On returning to Teachers' College, I gave nearly an hour's talk to an educational class on the value of the convention. I also told them that if this talk stimulated them sufficiently to attend the next one that they had an opportunity to, I should feel that the time taken was well worth while.

It seems to me that there is a distinct improvement in the spirit of these conventions with reference to a broader and more generous outlook on the profession. We are tolerant of other ways of doing, and with this tolerance we are learning to recognize values that a few years ago were not so easily appreciated. In the teaching of so complex a subject as music, such tolerance and breadth speak very hopefully for the future of the music supervisor's work and place the convention as one of the great features for cultivating a true appreciative attitude.

FROM OUR PRESIDENT

Professor Peter W. Dykema, Madison, Wis.

The Grand Rapids Meeting of the Music Supervisors' National Conference was a worthy successor to the splendid gatherings that had preceded it. It represented a natural growth in the attendance of active members. It showed a greater solidarity of effort and it marked another step in the insuring of permanency and continuity of work of the organization. There was manifested that same hearty good fellowship, that surprising enthusiasm, and that broad tolerance which has made it unique as an educational gathering.

While from the multitude of ideas that were presented, it is difficult to present a few as the most striking ones, it seems to me that the dominat-

ing notes were (a) the stressing of the necessity of more adequate preparation on the part of the supervisor; (b) the reiterating of the need of better musical material for teaching purposes, especially folk material for singing and dancing by the children; (c) the extending of musical activities throughout the community, both through instrumental work with children and the various manifestations of community music with adults; (d) the insistence upon results rather than methods; and (e) the upholding of the spiritual end as the great goal toward which supervisors must strive.

The local work under Mr. John W. Beattie's skillful direction was extremely helpful and suggestive and will serve as a model for many endeavors in the future. One noteworthy point in this connection was the opening of all the schools in Grand Rapids for inspection by the visitors. It was evident that Grand Rapids was willing that we should see their regular work rather than something prepared merely for visitors.

REVIEW OF THE CONFERENCE BY DAYS

First Day, Monday, March 19, 1917.

LIST OF SCHOOLS FOR VISITING MONDAY, A. M.

Work begins at 9:00

Allow 15 to 20 minutes for reaching school. Select school you wish to visit and get ticket at headquarters.

SCHOOL, TEACHER IN CHARGE, GRADES, CHARACTERIZATION.

1. Lafayette, Mr. Beattie, 1 to 7, American children.
2. Plainfield, Miss Allen, 1 to 6, American-Holland.
3. Union, Miss Dunn, 1 to 7, Many Nationalities.
4. Coit, Miss McGurrin, Kind. to 6, American.
5. Henry, Room teachers, Kind. to 6, Interesting work by room teachers.
6. Jefferson, Miss Craw, 1 to 7, American.
7. Oakdale, Mrs. Piper, 1to 6, Holland.
8. Hall, Miss James, 1 to 7, Holland.
9. Diamond, Miss Biddle, 1 to 7, Holland.
10. Sigsbee, Miss Dawes, Mrs. Gray, 1 to 8, American.
11. Straight, Mrs. Johnson, 1 to 7, Mixed Nationalities.
12. Sibley, Miss Martin, 1 to 6, Mixed Nationalities.
13. Central High, Mr. Berry, 9, 10, 11, 12, Harmony-History of Music.

LIST OF SCHOOLS FOR VISITING MONDAY, P. M.

Work begins at 1:15.

Select school you wish to visit and get ticket at headquarters. Allow 15 to 20 minutes for reaching school.

SCHOOL, TEACHER IN CHARGE, GRADES, CHARACTERIZATION.

14. Lexington, Mr. Beattie, 1 to 8, An average school with an eighth grade presenting problems with changing voices. Violin class at 3:30, Mrs. Shinkman, Director.
15. Fountain, Miss Allen, 1 to 5, American children.
16. S. Division, Mrs. Piper, 1 to 7, One of the city's "melting pots."
17. Buchanan, Miss Hudson, 1 to 6, American. Work will include listening lesson.
18. Alexander, Miss Craw, 1 to 7, American.
19. Madison, Miss Eddy, Miss Thole (Student), Room teachers, 1 to 7, American.
20. Palmer, Miss Richards, 1 to 7, American and Holland, Violin class 3:30. Miss Fischer, Director.
21. Congress, room teachers, 1 to 6, interesting work done by room teachers and by Miss Pitt (Student).
22. Pine, Miss Emmer, 1 to 7, American and Polish.
23. Widdicomb, Miss Oakwood, room teachers, Kind. to 6, exceptionally good second grade work.
24. Sibley, Miss Martin, 1 to 6, Mixed Nationalities.
25. Junior High, Miss Strong, 6, 7, 8, 9, an interesting working out of problems peculiar to this type of school. Assembly at 2:45.

Grand Rapids Course of Study

Each of the visitors when he received his ticket entitling him to visit work in the Grand Rapids Schools obtained also a statement which Mr. Beattie had prepared concerning the work of his department. This was as follows:

A STATEMENT OF OUR AIMS

The course of study in music in the Grand Rapids Public Schools is based on my belief in regard to the ultimate aim of school music teaching as expressed in a paper read during the National Conference of Music Supervisors at Pittsburg in 1915. In this paper I said, "The ultimate aim should be to create in the community, through the schools, a musical feeling. By musical feeling, I mean a desire on the part of the people to hear and ability to appreciate music in all its forms and what is more important, a desire for opportunity to express themselves musically through any form and the ability to do so." Briefly stated then, through our music teaching in the schools of Grand Rapids, we are trying to develop a public which will be able to listen intelligently to all kinds of good music. The ability to listen intelligently will, of course, foster the desire to do so. We are also endeavoring to make it possible for a great many people to take part in the actual performance of music in some one of its various forms.

A clear understanding of our aims is necessary in order that some of our procedure may be understood, and its value accurately gauged.

MUSIC TAUGHT THROUGH SINGING

The ability to sing is almost universal. For this reason singing has been made the basis for music intruction in nearly all school systems. It is the most logical and natural way to interest children in music, and furnishes a medium for a considerable amount of instruction in the rudiments of music. However, too many people who have to do with the teaching of music in schools place the emphasis on this formal knowledge of music which can be gained through singing, rather than on the singing as a beautiful means of expression.

SIGHT SINGING TAUGHT AS A MEANS OF DEVELOPING GOOD SINGING

The study of notation as applied in sight singing is introduced too early in many school systems If the entire music period during the first year is given over to the singing of rote songs which are beautiful musically, and whose words are within the understanding of children, the pupils will acquire two things which are invaluable in the teaching of the more

formal side of music. These are a love for music and the ability to imitate surely and quickly. Without either of these no real progress in the teaching of notation can be made.

The ability to read music at sight as practiced in public schools is of questionable value if considered from any other standpoint than as a means to an end, that end being the ready and accurate performance of music. As a matter of fact, few people except professional musicians, ,ever practice sight singing after leaving school. Practically all congregational singing in churches, lodges or social gatherings, is done to the accompaniment of an instrument and with the added leadership of a choir, who in turn have learned their parts from an instrument. The teaching of sight singing in the schools will not alter this condition. But if the children are taught to sing well and to love to sing, congregational and social singing in future years will become a thing of joy. And if instruction in reading music in school can be combined with beautiful singing, the very desirable results which will follow will surely be admitted by everyone.

That is what we are working toward in Grand Rapids. We spend all the music time in the first grade singing. Half the time in the second grade is also put upon singing, and singing is the important feature of all our music work in the first four grades. By singing we mean proper tone placement, careful enunciation, correct phrasing and intelligent interpretation. Most of the interpretation has to be left to the teacher but we try to use only such songs as will mean something to children. No vocal exercises are used and few exercises of any kind. Sight reading can be developed just as easily through songs as through so called exercises. And after children have mastered a good song, they have something of real value.

THE DEVELOPMENT OF THE LISTENING HABIT

During these first four years, we also develop the ability to listen. Several sets of phonograph records are circulated among the schools. These records are mostly of simple songs and stories which appeal to young children. A few instrumental records are included. The idea is not to give formal instruction about the selections given out through the records, but to cultivate a listening attitude which will be useful in later years of the school life.

MUSIC IN THE INTERMEDIATE GRADES

Part songs are introduced in the fifth grade in a limited way, but children are not assigned permanently to any part until range and quality of their voices justifies it. Children learn to sing either first or second part with equal facility, by alternating on these parts as new songs are taken up. As a result of this practice, we have very few changed voices in our upper grades, and the "boy problem" is almost nil. We spend no time in drill on key signatures or the writing of major and minor scales in any grade. We expect children in the sixth grade and above to be able to tell on what degree of the staff the key note is, but that is as far as our training in theory goes. Further knowledge is unnecessary for sight reading as practiced in most schools in this country. A slight knowledge of the theory of music is quickly lost by those who do not use it as applied to the study of any instrument. Since it is not our object to pre-

pare a few pupils for the piano and violin teachers, but to give every pupil something which will be of lasting value after his school life, we believe we are justified in spending almost all of the music time in singing songs.

INSTRUMENTAL MUSIC

Beginning in the fifth grade free instruction on any band or orchestral instrument is offered. This instruction is given in classes by outside teachers who work with the children after school hours. As soon as they develop sufficient ability, these children are permitted to join the bands and orchestras.

An appreciation of music is developed through the use of phonograph records. Twenty sets of records covering a wide range of subjects circulate freely through the central office and each school which owns a phonograph, also has records of its own. In addition to the work with the phonograph, an annual symphony program by a visiting orchestra is provided the children of the city at an admission fee of twenty-five cents.

MANNER OF CARRYING ON WORK

Much of the instruction in vocal music is given by the grade teachers. I prefer this arrangement wherever it is possible, as I believe that a good music lesson reacts on the teacher in a very beneficial manner. It makes her a better and more inspiring teacher the remainder of the day. But a teacher who cannot conduct the music lesson in an efficient way should be relieved of the work, for her own sake, as well as that of the children. We provide special teachers of music in some buildings where we had obtained poor results from grade teachers, and also have specials in buildings where departmental work is carried on.

None of our work is outlined week by week. No two schools can cover precisely the same ground in a given time in any subject. If one fourth grade can learn two songs while another has difficulty in mastering one, it would be an injustice not to permit it to go ahead. Whenever a school covers all the material in a book before the end of a term, we try to furnish additional material.

A record of the work done is kept by every teacher. This is done both for the benefit of the room teacher, and the supervisor. Each room is visited by a supervisor once a month.

Seventy-five minutes per week is the time given for music.

The list of teachers in the department of music in Grand Rapids is as follows:

John W. Beattie, Supervisor; Florence Allen, Assistant Supervisor; Iren McGurrin, Kindergarten Supervisor; Leon F. Beery, Central High; Kathryn H. Baxter, South High; Irene Dunn, Union Elementary and High; May Strong, Jnior High; Anna Dawes, Sgisbee; Maria Hudson; Buchanan; Della James, Hall; Lou A. Piper, Coldbrook, Oakdale, and South Division; Ethelyn Craw, Turner, Jefferson, and Alexander; Leo E. Ruckle, Bandes and Orchestras in Elementary Schools.

The following named teachers divide their time between music and physical education:

Ethel O. Johnson, Straight; Hazel Richards, Palmer; Nellie Martin, Sibley; Katherine Sheehan, Sheldon.

The following named grade teachers are responsible for the music in six rooms:

Elizabeth Oakwood, Widdicomb; Florence Emmer, Pine; Louise Biddle, Diamond; Carol Holt, Henry.

THE COURSE OF STUDY

KINDERGARTEN

Twenty rote songs selected from a classified list of 86. This list is prepared by the Supervisor from the following books:

Lyric Music Series—Primer	Scott, Foresman Co.
The Song Primer	A. S. Barnes & Co.
Songs of a Little Child's Day	Milton Bradley Co.
Eleanor Smith Primer	American Book Co.
The Congdon Music Reader, Book 1,	C. H. Congdon
Progressive Music Series, Book 1,	Silver, Burdett & Co.
Small Songs for Small Singers	G. Schirmer
Primary Melodies	Ginn and Co.
Mother Goose Songs	Milton Bradley Co.
First Year Music	American Book Co.
Song Development for Little Children	White-Smith Music Pub. Co.

GRADE ONE

Forty rote songs selected from a classified list of 114. This list is prepared by the Supervisor from the following books:

Primary Melodies	Ginn & Company
Progressive Music Series Book 1,	Silver, Burdett Co.
Small Songs for Small Singers	G. Schirmer
Songs and Games	Novello, Ewer & Co.
Lilts and Lyrics	Clayton F. Summy
First Year Music	American Book Co.
Lyric Music Series, Primer	Scott, Foresman & Co.
Songs in Season	A. Flanagan Co.
Modern Music Series	Silver, Burdett & Co.
Mother Goose Songs	Milton Bradley Co.
Teachers' Edition, Book I. N. E, M. C.	Ginn & Co.
Churchill-Grindell Song Book II,	Churchill, Grindell Co.
The Song Primer	A. S. Barnes & Co.
Song Stories for the Kindergarten	Clayton F. Summy Co.
Primary Song Book	A. Flanagan Co.
Songs and Games for Little Ones	Oliver Ditson Co.
Fifty Children's Songs	G. Schirmer
Song Development for Little Children	White-Smith Music Publishing Co.

Many schools learn as many as eighty songs. Care is taken to get the voices unified in this grade, if possible. Individual work is done with those children who are backward musically.

GRADE TWO

Twenty rote songs selected from a classified list of 50. This list is prepared by the Supervisor from the following books:

Songs in Season	A. Flanagan Co.
Primary Melodies	Ginn & Company
Songs and Games	Novello, Ewer & Co.
Lyric Music Series—Primer	Scott, Foresman & Co.
Lilts and Lyrics	Clayton F. Summy
Small Songs for Small Singers	G. Schirmer
Churchill-Grindell Song Book II,	Churchill, Grindell Co.
Teachers' Edition, Book I. N. E, M. C.	Ginn & Co.
Progressive Music Series Book 1,	Silver, Burdett Co.
Eleanor Smith Music Course, Book 1,	American Book Co.
Fifty Children's Songs	G. Schirmer
Song Stories for the Kindergarten	Clayton F. Summy
Song Echoes from Child Land	Oliver Ditson

Introduction of notation and sight singing.
Material—Congdon Primers I and II.

GRADE THREE

Further development of sight singing.

Material, New Educational Music Course, Book One pages 1-45. Eleanor Smith Course, Book One, Songs selected by superviser.

Rote songs of teacher's choosing.

GRADE FOUR

Introduction of divided beat, dotted quarter (beat and a half note) sharp four and flat seven.

Material: N. E. M. C. Book One, part two. Schools which finish this before the end of the year take up two part work.

GRADE FIVE

Further use of intermediate tones; figures employing difficult combinations of quarter, eighth and sixteenth notes; two part singing.

Material: N. E. M. C. Book Two.

GRADE SIX

Strengthening of principles learned in preceding grades through their continued application in more difficult songs.

Material: Songs selected from N. E. M. C. Book Three and Junior Laurel Song Book.

GRADE SEVEN

Introduction of three part songs.

Material: Songs selected from N. E. M. C. Book Four and Junior Laurel Song Book.

GRADE EIGHT

Review of principles learned in preceding grades, through their application in more difficult songs.

Material: Songs selected from N. E. M. C. Book Five

and Junior Laurel Song Book.

Note: There may well be inserted at this point some notes on public school music in Grand Rapids which were prepared by Miss Florence E. Allen, Mr. Beattie's first assistant.

In my demonstration work during the first two days of the Conference, my endeavor was to show in a general way what had been accomplished in the preceding eight months and to demonstrate by taking up new material—not my methods of developing different problems—but the degree of independence attained by the classes. As nearly as possible the work proceeded as a regular lesson. The children were in no way primed for the exhibition.

Before all else, the aim has been to make the voices musical. Careful supervision from the first year of Kindergarten, where the average age is four years, has practically eliminated any monotones. By selecting simple and appropriate songs and using the piano only occasionaly, the listening ear has been developed and with this foundation, rote songs are learned quickly and accurately. The range is an important factor in the selection of the rote songs. Only such as naturally bring out the head voice are used. This runs below the staff, it is pitched in a higher key to bring it into the proper range. In the two part singing the parts are alternated in the different songs—every child in this way learning to sing a harmony part. Light flexible voices have by this stage been established into a settled habit and there are not many changed boys' voices in the upper grades. When rough heavy singing and flatting occur in any grade, the children themselves recognize the fault at once. No special vocalizing exercises seem necessary; the songs are hummed lightly or sung with loo until the tones are satisfactory. Our idea has been that a music period of clear beautiful singing, permeated with the joyousness that must go with it creates the desire to perform and the interest to hear more of the same high quality, and to what better purpose may we use this short time allotted our subject.

HIGH SCHOOL MUSIC COURSES

Music in the Grand Rapids high schools is on an elective basis. Courses I, II and III are offered in all three schools and are credited on the same basis. The more advanced courses are offered at present in Central High School only. Attendance at Union and South is increasing so rapidly that it is expected that a complete course of study in music will be adopted for all the high schools within a year or two.

150 credit hours are necessary for graduation. Serious music students are able to secure one fourth of these credit hours in the music courses.

I. Chorus: Two periods a week and a public program once a year.

Credit: one hour per semester.

II. Orchestra. Two periods a week, appearance at every school assembly and occasional public programs. The orchestras have been very popular and in almost too great demand for appearances at public gatherings of all kinds, the money going into the orchestra fund. Instruments, music stands, and music have been acquired very largely from this fund. Bands are organized rather intermittenly and are of the greatest service at athletic contests.. They also furnish training for the wind instrument players who cannot get places in the orchestra.

Credit: One hour per semester.

III. Applied Music: Private lessons in piano, voice, pipe organ or instrument of the symphony orchestra. One lesson per week and a minimum of six hours practice is required. At the close of each semester, a card signed by both teacher and parent certifying that these requirements have been carried out is handed in. This card also contains a list of work covered, furnished by the teacher. Examination is then given by the Supervisor of Music who has the privilege of rejecting the work of any student if in his opinion, it is unworthy of school credit.

Credit: Two hours per semester.

IV. History and Appreciation of Music. Five hours recitation per week throughout one year.

Credit: five hours per semester.

V. Harmony. Three hours recitation per week throughout two years.

Credit: three hours per semester.

DESCRIPTION OF COURSE IV

Prepared by Hubert S. Conover

In presenting a course in the History of Music to students of high school age, or to beginners at any age, it is inadvisable to present in an extensive manner, any material dealing with the subject prior to the beginning of the eighteenth century, i. e., the beginning of modern music. The earlier material may be presented in an advanced class, after the subject has been brought down to date, and the students will be found to have acquired sufficient background to enable them to gain an adequate conception of the primitive steps in the History of Music.

Music History must always be regarded as but a branch of general Culture History, and the instructor should constantly call the students

attention to parallel or contrasting movements in Literary or Art History, or General History. The specific purpose of a course in Music History is not the acquisition of definite knowledge on the students part, but the broadening of his general culture, and in particular, the cultivation of his taste and discrimination in matters musical, transforming him from the casual listener to the intelligent listener.

The composers to be studied may be classed conveniently into four groups, comprising those whose activities occupied approximately, A. the eighteenth century, B. the first third of the nineteenth century, C. the middle third of the nineteenth century, D. the period from 1860 to date. The subject may be offered in a two year course meeting twice or three times a week, taking one group each semester, or it may be covered in a year, the class meeting four or five times a week.

The following list of composers is suggested:

Group A	Group B	Group C	Group D
Handel	Beethoven	Schumann	Wagner
Bach	Weber	Mendelssohn	Brahms
Haydn	Schubert	Chopin	Gounod
Mozart	Rossini	Berloiz	St. Saens
Gluck	Meyerbeer	Liszt	Tschaikowski
		Verdi	Dvorak
			Grieg
			Strauss
			Debussy
			D'Indy

It has been found helpful to have the student take up each composer from the following stand points:

1. General question involved.
2. Forms of composition used, and most important works.
3. Contribution of composer to the development of music.
4. Characteristics of composer's style.
5. Biography of composer.
6. Performance of composers works by instructor, members of class, outside talent or through the use of phonograph and player piano.

As much should be left to the student as can be safely intrusted to his hands, the teacher leading the way, and developing the more difficult points.

DESCRIPTION OF COURSE V

Prepared by Leon F. Berry

PLAN OF WORK.

Mechanical melodic invention; harmonizing melodies, assigned and original; harmonizing basses, figured and free; music analysis, hymns and piano music; ear training; keyboard harmony; original free composition, emphasizing piano style.

The above is applied to each step of the following:

TOPICAL OUTLINE.

Major scales and signatures; the tonic chord; the dominant chord associated with the tonic—the common tone principle; the sub-dominant chord associated with the tonic; progressing from sub-dominant to dominant—the contrary motion principle; non-harmonic tones—passing tones, etc; the three primary triads in minor; minor scales and signatures; intervals; the dominant seventh chord; inversion—melodizing the bass; simple modulation by means of the dominant seventh; substitute chords—VI in place of I, III in place of V, etc; the leadingtone seventh chord, and other seventh chords; further work in modulation; ninth chords, and altered chords.

(Note—The above outline is intended for classes averaging three recitations per week. The ability of the students will largely determine whether all the steps in the outline can be covered.

Monday Evening Program

The Department of Music of the Grand Rapids Public Schools presents the Choruses and Orchestras from Central, Union and South High Schools in a concert for the entertainment of the National Conference of Music Supervisors at the Armory, Grand Rapids, Michigan, Monday Evening, March 19, 1917.

Program

1. Triumphal March (Aida)........................*Verdi*
Combined Orchestras
Direction of John W. Beattie

2. "Daybreak" (Longfellow)................*Eaton Faning*
Union High School Choral Society
Alice Haralstad (Class of 1916) Accompanist
Direction of Irene E. Dunn

"Lovely Appear," (The Redemption)............*Gounod*
Accompaniment arranged by Luther R. Moffitt
Union High School Choral Society and Orchestra
Ruth Lytle, Soprano
Direction of Mr. Moffitt

March, Opus 18, No. 3..........................*Gade*
Arranged by Luther R. Moffitt
Union High School Orchestra
Direction of Mr. Moffitt

3. "The Bells of Shandon"............*Annie W. Patterson*
"My Bonny Lass She Smileth"............*Thos. Morley*
Madrigal for five voices

"The Lass with the Delicate Air"..............*Dr. Arne*
Central High School Chorus
Laurena Davis and Helen Bloomer, Accompanists
Direction of Leon F. Beery

4. "The Lord Is Great" (Arr. from Athalia) *Mendelssohn*
"Moonlit Meadows"..........................*Szibulka*
South High School Chorus and Orchestra

"Now, May Again" (First Walpurgic Night) *Mendelssohn*
Sanctus (St. Cecilia Mass)...................*Gounod*
South High School Girls Glee Club
Janet Jenkins, Accompanist
Hilda Bell and Charles Plasman Cellists
Direction of Kathryn Hamilton Baxter

5. "The Deacon's Masterpiece" (The One Hoss Shay)....
Percy E. Fletcher
The Combined Choruses and an Orchestra selected from the present and alumni membership of the high school orchestras.
Direction of Mr. Beattie

The following account of the Monday evening concert was written by M. Philip C. Hayden and published in the March-April, 1917, number of his *School Music* (50c a year, Keokuk, Iowa.)

Monday evening at 8 o'clock, a crowd that completely filled the large Armory assembled to hear a splendid program. The choruses of the three large high schools rendered selections and combined choruses and a selected orchestra gave Percy E. Fletcher's "The Deacon's Masterpiece," or "The One-Hoss Shay."

The first number, conducted by Mr. Beattie, and given by the combined orchestras of the three high schools, was the most satisfactory number of the evening. The orchestra was well balanced. There were marked extremes of volume, the players passing gracefully from "p" to "ff". It was a beautiful piece of work, for a student orchestra, which Mr. Beattie drew out from the young players.

The singing of the various high school choruses was quite satisfactory although the tone quality, especially of the sopranos did not fulfill the promise shown by the voices in the Junior High School.

The performance of "The One-Hoss Shay," or "The Deacon's Masterpiece" showed a well trained chorus, able to follow the score in unusual harmonic and rhythmic conditions. In this performance the piano gave very decided support to both orchestra and chorus under the hands of Mr. Ferdinand Warner. This work of Mr. Percy E. Fletcher gives promise of future productions, and he will undoubtedly write something of great excellence when inspired by a theme of more serious nature than the words used in this composition, "The Deacon's Masterpiece."

Second Day, March 20, 1917

LIST OF SCHOOLS FOR VISITING TUESDAY, A. M.

Work begins at 9:00

Allow 15 to 20 minutes for reaching school. Select school you wish to visit and get ticket at headquarters.

26. Diamond, T. P. Giddings (Minneapolis), 5-6-8, Demonstration of sight reading according to Minneapolis plan.
27. Sheldon, Eleanor Smith (Chicago), Kind. 3-5, Song interpretation and sight reading.
28. Lafayette, W. A. White (Des Moines), 1-2-5, Sight reading according to Des Moines plan.
29. Sigsbee, Agnes M. Fryberger (Minneapolis), 3-5-8, Listening lessons.
30. Michigan, Osbourne McConathy (Northwestern Univ.), 2-4, Sight reading.
31. S. Division, J. Beach Cragun (Chicago Univ.), 5-7, Tests in rhythm and intervals as conducted for school surveys.
32. E. Leonard, Margaret M. Streeter (Chicago), 3-6-8, Foresman records.
33. Union, Lillian McCracken (Boulder, Colo.), 1-3-5, Interpretation and sight reading.
34. Madison, Catherine Strouse (Emporia Normal), 1-2-3, Rote song work and introduction of divided beat and sharp four.
35. Fountain, George Oscar Bowen (Yonkers), 2-4-5, Demonstration of sight reading according to Weaver System.
36. Franklin, Mr. Beattie, 1 to 8, Children largely Holland and Syrian. Solution of vocal difficulties.
37. Congress, Miss Allen, 1to 6, Average children.
38. Turner, Miss Craw, Miss Kinsella, 4-5-6, Interesting work with a school made up largely of boys.
39. Coldbrook, Mrs. Piper, 1 to 8, Holland and Jewish chilren. Solution of vocal difficulties.
40. W. Leonard, Miss Oakwood, Kind. Ungraded 1 to 5, Polish, Lithuanian, and Holland children. Splendid Kindergarten and interesting ungraded room.

REPORTS ON DEMONSTRATION TEACHING

All of the visiting supervisors who did the demonstration teaching were asked to give a report of what they had done. The material of those who responded is printed below.

REPORT OF CLASS TEACHING AT GRAND RAPIDS

By Mr. T. P. GIDDINGS, Minneapolis.

Efficiency is the watchword in school work as well as other occupations. It is particulary important here. It is only a part of our duty to impart the knowledge the pupils need. The rest of our duty is to see that

the pupil learns to use his mind in an efficient manner. The thing that counts for mental efficiency in after life is not so much the knowledge he acquires as it is the efficient mental habits he has developed while gaining this knowledge. Teachers should keep this constantly in mind and pupils should not only be taught to do their work in the best and most efficient manner but they should be taught to watch the way their minds work and see if they are training them properly. .

This educational idea is with me in all the school work I do and this was what I endeavored to demonstrate in a few concrete ways at Grand Rapids.

At the beginning of the forenoon I announced to the visitors that I would teach several classes in sight singing and would proceed exactly as if I were visiting my own classes in Minneapolis.

Before beginning I further explained the logical sequence I have the pupil follow in reading new music. Briefly it is this. Sing, time, notes, words, expression. These are the things that go to make up perfect sight singing and they should either be done all at once or in this order if the pupils cannot carry on all at once. If the pupil is able to read at sight he is able to do all five at once and the music will be perfectly performed at the first reading. This is our ideal and both teachers and pupils should know it and constantly strive to reach it. If the reading is not perfectly done, a glance at the above sequence will show the reason and the weak spot can be seen by both teachers and pupils.

If the pupils are able to do but one thing when they go through a piece for the first time, this one thing must be to make a smooth pleasant tone. If they are able to do two things the first time through, these two must be to make a good tone and get the time right. If they are able to do three, these three must be in the order named, sing, time, notes. If they are able to do four at once, these four must be, sing or make a tone, time, notes, words. If they can do all five they will be doing real "sight-reading", or "sight-singing" is a far better term.

If the pupil is to learn to read music well and develop good habits of mind, he must follow this logical sequence rigidly. If he does not follow this he will not be able to read fluently and musically, and he will have picked up a lot of shiftless mental habits at the same time.

All the rooms I taught were right up and coming and ready to do anything asked of them. They were well trained, read music well and sang with a delightful tone. It was a pleasure to work with them.

The first class was third grade. After asking the visitors to keep the above logical sequence in mind I asked the class to read a new song. They did it and it at once developed that they were not in the habit of using a tone that was smooth enough to allow them to hear imperfect intonation and I spent a few moments in improving the first number of the logical sequence, or the "sing." The pupils learned to make a smooth tone by placing their left hands on the ribs and abdominal muscles and making these muscles move steadily. This soon remedied the tone.

It also developed that they stopped the regular flow of the rhythm whenever they came to a note that they did not know. This showed that they were thinking of their notes before the time or in other words their logical sequence was out of joint in that they did the third thing before the

second. They had been in the habit of holding the books up with one hand and pointing to the notes somewhat carelessly with the other. To remedy this, I had them place their books flat in the middle of the desks, where I could see them point.

This made the room look more orderly and it had an immediate effect. The orderliness of the looks of the room made them more orderly in their thinking and the fact that I could see every hand and what it pointed to made them point more carefully. Then I told the pupils of the logical sequence and told them they must keep their hands going in perfect time no matter how many of the notes they miscalled. This made the time better.

Many of the pupils stopped and looked at me for help whenever they came to a hard place. Several of the visitors hummed a little to help the pupils over these hard places. I reminded them that helping was not teaching, and they desisted. One of the visitors then asked me what the underlying principle of education was, and I replied it was "Root, hog, or die". In better language teaching the child to help himself was true education.

I then explained this to the class by showing them that I could not help them anyway as I had no book; that it would spoil their brains and they would be grown up babies instead of men and women if people helped them use their heads just the same as it would spoil their legs if some one carried them continually. I impressed upon them that they should look at their books for help. Then they did better. After extracting a promise that they would scorn all help in the future except what the book gave them we went to the next class.

This class was a fifth grade and I demonstrated the same principles as they appeared necessary.

In the seventh grade class the pupils sang a piece in three parts. After singing it through twice with the syllables they had trouble in putting the words to the music. Instead of looking at the notes to see what tones to use they were trying to remember the tune. To remedy this I had them take a new song, words first. They had some trouble but did very well after a trial or two.

This class did not sing well in tune. When this is the case it is idle to expect to teach music until the class as a whole can sing in tune. It will not be music until they do and music first is the slogan. It showed plainly that part of the trouble was due to a few pupils who sat in the back of the room and sang too loudly. I changed their seats to the front of the room and had them sing softly. This helped but did not cure the trouble. It also developed that the pupils did not listen to the other parts when they sang and so were unable to sing together well either in time or tune. I told them that to sing well together they must not only listen to all the parts all the time, but they must also read all the parts all the time. On asking how many could read all the parts, but few responded and I spent a few minutes teaching them to read music harmonically or in other words teaching them how to listen for and look at all the parts at once when reading new music. This was done by having them hold certain chords and dropping out one or two parts and bringing them in again so that all had a chance to learn to hear the chords more plainly.

This helped a little but still the intonation was not perfect, I then gave them a short talk on the interference of sound and showed them how to listen for beats and how to eliminate them both in each separate part and between the parts. They then began to make and hear smooth chords and the work sounded better. I also had to teach this class to sing with a smoother, longer, tone by placing the left hand on the rib and abdominal muscles and making these muscles move steadily. This work interested the pupils immensely as it always does at this age and the smooth chords they were able to make after learning exactly what to do and what to listen for were very beautiful and appealed to the pupils very strongly. They are very sensitive to beautiful harmonies at this age and this form of ear-training is very valuable if it is applied to the daily work in a sensible manner.

These three classes took all the allotted time. Instead of taking the rest of the time for discussion, at the request of the visitors I took a fourth grade class and went over much the same ground as before.

After this there was a free discussion of the various phases of school music until the time came for us to hurry to the high school to hear the inspiring assembly.

REPORT OF PLAN OF TWO LESSONS

By Miss Eleanor Smith, Chicago, Ill.

In planning my First Grade Lessons for the Grand Rapids Conference, I had in my mind a desire to show some methods and material that might help to bring more positive and definite results than those often to be observed in First Grade schools.

The more or less correct imitation of the teacher in a large number of songs the texts and melodies of which are often beyond the comprehension of children of six cannot be relied upon to produce the musical development on which to build the child's subsequent musical career.

Specialists would doubtless agree that technical instruction can effectively be given only to those children who can sing; but the fact that many Supervisors consider their proper work to begin in Second Grade with the inauguration of technical study, must be taken as evidence that they do not fully realize how important is the work to be done earlier. It would seem that children who are receiving their first instruction in music and who are the most difficult children to teach should have the most careful and skillful teaching. Certainly the acquisition of technical facts for those who cannot sing is a most sterile accomplishment. To be able to sing simple tunes correctly and simply is naturally a first condition of technical knowledge and facility.

It will be found that the average First Grade shows a large proportion of children who are not musically independent. Perhaps less than a third are apparently tone-deaf but not more than a third can sing simple tunes correctly. The remainder gets on more or less happily with help. To give the unstable majority the sort of teaching which will aid in establishing their musical independence, in other words, will teach them to sing, is to my mind one of the greatest problems confronting the teacher.

It has been my experience that other material than even the simplest conventional melodies is needed at this time.

Especially effective I have found little music dialogues such as may be found among folk games. These should in the beginning be composed of very easy phrases and which are repeated by the children after the teacher and which are arranged to little rhymes embodying question and answer. The advantage of these little dialogues is that they are often accompanied by games which will arouse fresh interest in singing; that their music-content is the simplest; that phrases are many times repeated without becoming monotonous. The fact that they furnish variety is another point in their favor, as well as the fact that the little people are learning something without effort or consciousness. Best of all, such devices provide the most natural and spontaneous opportunities for individual singing.

My first Grade Lesson therefore included:

(1) The teaching of a simple folk-song.

(2) Several dialogues.

(3) The easiest vocal exercises.

The song chosen was a Flemish folk song.* This is a good typical song for First Grade. The melody is most simple and attractive. The text contains few words not in the child's vocabulary and no thought strange to his experience. It was therefore necessary mainly to allow the children repeated opportunities for hearing the song. A piano was at hand and the melody was sung and played repeatedly with pauses for the discussion of the text.

A poster illustrating the song had been provided. This was shown the children and aroused the usual interest in pictures. Rosa's hat with its blue ribbons was talked about and the fact that her dress was pink and white and that her shoes were new and shiny.

After repeated singing of the song by the teacher and discussions by the class of the text, the children were allowed to sing the song for the first time. As usually happens when the tune has been sung a sufficient number of times by the teacher and when its content is comprehensible to the children, the larger number of them were able to sing it for the first time without mistake.

Teachers of experience who realize the difficulty of correcting mistakes once made by little children will realize the advantage of this method. The interest of little pupils in hearing a new song makes it possible to ask them to listen until the song has been learned without conscious effort on their part.

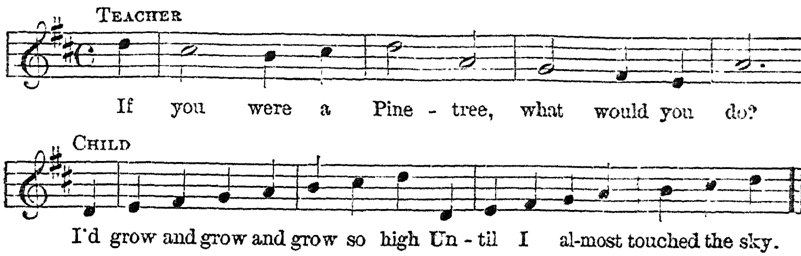
In order to insure a more spirited interpretation the Grand Rapids children were encouraged to choose partners and skip through the lively dance tune. This they did with much enjoyment and the subsequent singing of the song showed great improvement.

DIALOGUES

Three types of dialogues were presented, all of them successfully. The first and simplest of these was one in which children and teacher sing the same tune, phrase-wise.

**Dancing with Rosa, Eleanor Smith. Primer-p. 45.*

The second shows a slightly more difficult form. The teacher asks her question using one little tune. The children reply using a different tune.



The third is a so-called ball game, a little exercise in which the teacher throws a little music ball to the children which they in turn throw back to her. The repeated melodic figures are so arranged that they form a simple melody.

Such little tunelets divided into the smallest phrases naturally suggest themselves as material for learning syllables later, and can be given in great variety.

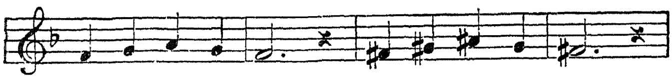
VOCAL EXERCISES

I am aware that many Supervisors consider vocal exercises superfluous in the school room. Others feel convinced that beautiful tone quality can never be so easily acquired as by the help of vocal exercises. It seems to me that as children's voices are adult voices in miniature, anything can be adapted to the same use with children. No sane music teacher would strive

to develop children's voices as those of adults are developed. For instance, no teacher of discretion would work for great flexibility power or wide compass.

But exercises whose function are to relax tongue and jaw to secure normal tone placement and the elements of breath control are to my mind most important in the school room. It is needless to add that such exercises can only be of value when given by a teacher who knows their use and can sing them properly.

The vocal exercises given in the First Grade lesson consisted of long sustained tones from F to C, given with *ah* and *a* in chromatic sequence. A second exercise was designed to relax the jaw and to encourage a soft loose tone as:



La la la la la La la la la la etc.

SIXTH GRADE LESSON

The work of this grade naturally stresses part-singing and seeks to famiiliarize pupils with music problems of increasing difficulty. Concentration on the more intellectual side of music is likely to result in loss to the vocal and interpretive aspects of the subject. Reading in parts, in Sixth Grade, is in itself a somewhat strenuous business, especially when three-part singing is practiced. The struggle to accomplish the mere skeleton of the song right rhythm and melody, usually results in a more or less mechanical product so that unless a certain number of rote unison songs are given the children singing undergoes decided degeneration.

I hoped in my Sixth Grade Lesson to suggest a means of interpretive improvement, which also has the advantage of added different technical work. A unison song of dignified character was chosen and one which appeals to the children of this age because of its beautiful text. It was planned to teach this song by rote in order to free the mind for beautiful singing, in itself a complicated performance. It may be formed in the new book, *Antiphon* by Eleanor Smith, a Childrens Hymnal (In Press American Book Company.)

After some discussion of the text in which its meaning was brought out, and its beauty dwelt upon, the song was sung and played a number of times in its entirety by the teacher. It was then learned by imitation phrasewise, much attention being paid to proper pronunciation, phrasing, intonation and smooth tone connection without slurring or sliding.

Vocal exercises were given to improve the tone quality of the children. They consisted in ascending arpeggios and descending scales with clear vowels, also ascending octaves.

In conclusion, a part of the song was written by the class. Syllables were readily found for the tones composing the melody. A decision as to rhythmic structuce was somewhat more slowly made. On the whole, however, the writing was well and quickly done. One pupil was able to hear a modulation from D major to F major and to define the interval deciding the new key.

The teacher temporarily in charge regretted that her time would not allow for the entire song to be written. The children were helpful and full of interest and the hour flew quickly.

Resume of Demonstration of Mr. Wm. Alfred White and Assistants, Miss Elizabeth Burney and Miss Hazel Granger, at La Fayette School.

In the first grade several songs were taught by rote; the scale and the tonic chord are each distinct musical ideas, and these were taught by rote, as a result of the songs, relating the tonality and key-feeling of the song to the scale and chord in which it was written.

A range of forty to sixty songs is taught in the Des Moines schools in the first grade, from which are developed certain definite musical ideas, such as phrase recognition, time and rhythm feeling and recognition, and their physical expression, the relation of each rote song to its proper tonality and key-feeling through the scale and the tonic chord, ear-training developed entirely from the material of the songs, and the application of standards and tests to the individual children. After a great many songs are known, the entire picture, in notation, is given on the board so that the eyes of the children are being trained by rote in the same manner as their ears were approached. All these points were demonstrated with the first grade children in La Fayette school.

In the second grade the work of the first grade was continued, but every song is observed by the eye as well as the ear; the eye is trained by rote to observe the phrase; to recognize exact similarities in phrases; to see exactly the same rhythmic pattern tho a different tonal pattern; the eye-recognition of the time indication related to the physical expression and the ear rote of the first grade; the recognition of the differences of tonality and key-feeling as expressed for the eye through the various songs; the recognition and placement of the key-notes of the various keys; the recognition and placement on the staff of the notes of the tonic chords of the common keys, all such developments to be an outgrowth of the song material used throughout the second year, with no extraneous material brought in.

This work was exemplified in the demonstration with the second grade children in La Fayette School, and as each point was developed and spoken of by the class the attention of the visitors was called to the point in question at the time.

Through a regular course of definite instruction this procedure is developed consistently and logically through the third and fourth grades, though there was not time to demonstrate this at the Grand Rapids meeting.

In the fifth grade sight-reading in both major and minor was given. The class used had never had a minor song, or minor material of any kind, hence the presentation was entirely new to them,, but they gave the work a most successful demonstration.

The tonality and key-feeling for the minor mode was established through the teacher singing the minor scale and the minor tonic chord, without any syllables whatsoever, or without relation to any major key. After a little observation of the staff-notation of this minor scale and chord a song in an entirely unknown book, to the children, was taken, and read at sight 95 per cent perfect. A visitor asked the demonstrator if the

children could attempt another minor song; one in the same key was selected, and read at sight, with the words, as easily as the first song was done.

A two-part song in canon form, in the major key, was given the class to read, with words. After a short study of the musical structure of the song, that is, its phrases, the relation of the melodic line to the scale and the tonic chord, and the rhythm, the song was read correctly in two parts with words; then the parts were reversed with an equally good result, without the use of syllables or similar devices. An attempt was made, on request, by the class to read and sing the same songs with the syllables, but they failed and stopped. The point was amply proven; after classes have drilled for four years on syllables, after a song is already known and can be sung with words, and the parts in a two-part song can be reversed after twenty five minutes of work, the whole system simply confused the minds of the singers, and music stopped.

The great underlying idea of the demonstration was to show that music is graphic; the notation is a positive picture of what tones and rhythms express; that by a related course of study with musical material and proper correlation of ear and eye, and a definite observation and understanding of the musical effects and their corresponding pictures, children can more easily learn to sing and to read music than any of the older methods have made possible. The classes in La Fayette School responded remarkably well, making the demonstration a success.

REPORT OF TEACHING

MRS. AGNES M. FRYBERGER, Minneapolis, Minn.

At the recent Convention, lessons in Music Appreciation were given in grades three, five, six, seven and eight. The presentation was largely through phonographic material.

The following points were considered fundamental in the demonstration:

To illustrate a method of conducting listening lessons in music so simple and direct that the grade teachers will use it.

To bring to the class the conviction that music contains things to think about and to talk about, and that it is not merely diversion or entertainment.

To emphasize the importance of conveying a definite impression and the equal importance of requiring definite expression from each child.

To convince the grade teachers that musical Esthetics is not a mysterious subject. That its fine emotional and intellectual stimulus give it high values in an educational course. That it has close application with language, reading, geography and history. That its presentation depends upon the same sound pedagogy as other subjects. That the same phychology also, is required in grading material to the natural comprehension of the child.

To illustrate the close relationship between language drill and music criticism—both depending upon choice of words and logical arrangement of ideas.

To develop some of the definite points to be noted in different grades about rhythm, melody, harmony, form and mood.

To illustrate some of the simpler points in disicriminatiing between good and poor musical composition.

Finally to convince—if possible—all those who heard the lessons that intelligent listening to music must begin early in life and be carried on persistently and logically through all grades. That with a corrected attitude toward the subject will follow increased respect and a demand for music that has in it something to think about.

A REPORT OF THE TEACHING DONE BY OSBOURNE McCONATHY, EVANSTON, ILL.

My object in the demonstration lesson with the second grade was to show how children might be taught to think in groups of tones (figures) instead of thinking from one single tone to the next. The process might well be compared with the present-day reading lesson in which the teacher aims to have pupils see entire words at one glance instead of first spelling out the word and then pronouncing it.

In carrying out my lesson the following steps were observed:

1st. Three rote songs were taught.

a. "Cherries are Ripe"
b. "A Surprise"
c. "The Holiday"

In the first of these songs the figure so-mi-do occurs. In the second Mi-fa-so and in the third so-la-so.

2nd. Singing the songs by neutral syllables the children were led to observe the recurrences of phrases.

3rd. The syllables to the songs were taught the children. As far as practicable, in so short a lesson, the children were led to apply the syllables themselves. The principle was established that the same syllables should be sung by recurring phrases.

4th. The figures mentioned in the first step above were discovered in the songs and taken for abstract drill until thoroughly familiar.

5th. The notation of "Cherries are Ripe" was written on the board and the points previously noted were studied from the song notation, namely:

a. The whole song.
b. The phrases with observation of their recurrences.
c. The figures so-mi-do.

6th. The so-mi-do figure was written on another part of the board for recognition and drill.

7th. In order to save time the complete process was not followed in the case of the other two songs, but the figures mentioned under the first step, which had been studied as noted under the fourth step, were written on the board beside the so-mi-do figure and used for class, group, and individual drill.

At this point a recess was taken and a lesson given to the fourth grade. Later the second lesson for second grade continued as follows:

8th. The song "Before and After Dark" was written upon the board. This song, it may be noted, is composed entirely of the three figures upon which the children have been drilling. The children were led

to observe this fact and individually to come to the board and sing the figures, indicating by the pointer the group of notes which they were recognizing.

9th. The words of the song were read individually and then in concert.

10th. The song was sung by words.

The class was a well trained second grade and, of course, could have completed the reading of this particular song in a much shorter time than was taken by my lesson. I think, however, that the visitors present recognized the fact that my object was not to teach the class a new song but was an effort to illustrate the various steps in the process of training children to think in groups of tones, to recognize groups of notes and to read with words.

In my lesson in the fourth grade I endeavored to illustrate the process of presenting and developing one of the rhythmic problems, eight notes in the quarter note beat.

1st. The class sung a song with which they were familiar in which this problem occurred.

2nd. By beating time as they sang, the problem was brought to the notice of the children and separated from its context.

3rd. The notation of two eighth notes was placed before the children and the rhythmic problem was sung to the tones of the descending scale.

4th. The rhythm study, "Dear Little Moon," was written upon the board and through scansion the children were led to recognize the occurrrence in the text of this study of the rhythm problem upon which they had been drilling. The notation of the rhythm study was placed upon the board and the children individually went to the board and scanned the poem while pointing to the notes which occurred with each beat. In the case of the eighth notes the object of the lesson was to lead the children to a realization that the two notes together formed a single rhythmic thought, and that they were not to be taken as separate ideas but as one idea.

5th. While some children scanned the poem others sang the syllables.

6th. The class sang the song with words.

It had been my intention to present this lesson from books, but through a delay on the part of the Express Company the books were not available and, therefore, the lesson was necessarily presented from the board in a form more abbreviated than I had planned. In the second grade I also had hoped to present material from the books, but for the same reason this plan could not be carried out.

The excellent response by the children of both classes made it easily possible for me to illustrate the points in my lessons and I take pleasure in this opportunity to express my pleasure in meeting such well trained and responsive classes and such a cordial force.

REPORT OF DEMONSTRATION TEACHING

Miss Lillian McCracken, Boulder, Colo.

Grades 2, 4 and 5 were assigned me and grades I and 7B were added by request of the visitors. Special subjects were Sight-singing and Interpretation.

Lessons in all grades are introduced by deep breathing and a tuning-

up process of from one to three minutes. The latter consists of humming and vowel exercises which insure enunciation and tone-placing.

Ear tests enter into the lessons of all grades from phrases of songs learned by rote up through the intervals of major, chromatic and minor scales and triads. Also the quick thinking of keynote in any pitch when the C of the tuning-fork is given.

Quick mental drill is given in the intermediate and upper grades in chord work in two, three, and four parts by means of dictating figures of the scale.

Knowledge and use of dynamics is tested by following prescribed direction of the baton; also in sustained tones in upper grades.

Memory is developed by writing phrases on the staff as the song is studied, which should also enter into their written examinations.

A rote song "The Carpenter" was introduced in the first grade by appealing to the familiarity with the Carpenter and his tools, and demonstrating the use of the latter. This elicits bright faces, alert minds, erect bodies, concerted action (rhythm) and enthusiastic anticipation, ready for the first stroke of the hammer. Light tones must always be used since it is the tools, not the carpenter, that are noisy. Contrast this with the lullaby of "Drowsy Drooping Lids" and the sympathies and understanding of the child are expressed in face and voice.

In sight reading in primary grades, train the eye to see the measure or phrase first in scale and chord progressions; then repetition and sequence. Sequence is like the Valley lilies, each little blossom is the same color and shape and fragrance but hung high or low on the stem. It is like the ruffles mother puts on the dress—same pattern, but set differently.

In the song where the phrase ends "fa" (third line), "la" (space below), ti, do", we should see the home-run "la-ti-do" rather than the interval "fa-la".

Where the divided beat occurs, an illustration on the board of two quarter notes and their equivalents in eighths and sixteenths are drawn and he realizes that the more legs he attaches the faster they run. Oral demonstration of the big clock in "tick-tock", the little clock "tick, tick, tick, tick", and the watch in "tick-a-tick-a-tick-a-tick-a" is sufficient.

Allow pointing "note by note" only for first time singing, lest it lead to the mechanical marking of time, which is sure to rob it of both rhythm and expression.

Marking of time should be only in the mind, impelled by the recurring accent.

Accuracy in starting a song or exercise may be obtained by the teacher counting one measure preceding, with proper accent and tempo, and requiring instant attack.

Memorize as you go. Sing with closed book as soon as it has been sung from the open page.

In more advanced work sight reading is more intelligently and effectually done if given time to scan the page, phrase by phrase.

Look out for leaps in melody and bumps in time values. Be prepared for chromatic intervals in relation to the preceding and following intervals. If difficult two and three part songs are used, look for "cues" in the accompanying parts.

This process of scouting holds the interest of the individual and awakens competition. Otherwise the running up against serious difficulties after he has speeded up will kill the engine and incidentally the interest of those most easily discouraged. Once started never give up nor look up. Looking up means defeat; therefore the eye must not wander from the page.

Interpretation with children is catching the meaning of the composer in text and melody plus the feeling and the understanding of the singer. It is the spirit FOR song, OF song, and IN song. Then get away from the symbols. Close the book. Cultivate memory. Cultivate following a director.

Sing to the child "do, mi so" as compared with "la, do, mi" and instantly the facial expression changes.

The 3d grade child sings the Scandinavian Folk Tune (1st Reader) beginning "mi, la, ti, do" with the real interpretation of the "cold winds blowing" expressed in his voice, tho the words have never been mentioned. He changes to the bright hopeful tones of the major even more quickly and sincerely than the 7th grader who has made a study of the major and minor effects.

Close the eyes and sing it to "loo" as a "song without words" but which has its story to tell.

Then touch the meaning of the accompanying dynamics. Contrast the above with the "Valentine Song" (1st Reader) in text, movement, message, facial expression.

Always speak to the child in musical terms: brace, phrase, pianissimo, crescendo, andante. Enlarge his musical vocabulary. Have him realize that these are as important in singing as his period and interrogation point in reading. They are guide-posts placed along the highway by the one who created the song. Get the general as well as the specific idea to be expressed. Correlate the dynamics with public programs. For instance, it is the beginning of knowledge to note the "movements" of a sonato or symphony in the program tho he know nothing of its form or teachings.

In grade 7B, "The Primrose" song is given. Lead him to note the beauties of the flower, the dainty color, form and fragrance. The sight of one may never have awakened any thrills within the child until, added to the rhyme of the poet is the beauty of the melody. The suggestion of the delicacy of the flower in well marked rhythm and shading will convey to him the message of the song.

Contrast this with the dignity and majesty of "O Mother Dear, Jerusalem" or the patriotic fervor of "Hats Off." Make him responsible for the giving out of the mesage with all its meaning and when it becomes a part of himself—with all the symbols of technique forgotten, he will have the meaning of the composer rhythmically and melodiously expressed. He himself will be the song.

I considered it a great pleasure to work with children so responsive and intelligent and well-trained as were the children of Union School—Grand Rapids.

REPORT OF TEACHING

Miss Catherine E. Strouse, Emporia, Kansas.

In the first class, I did purely initative work, basing it all upon the rote song. The class and I know a number of the same songs, so a few of those

were used to get a point of contact. Then I taught a rote song, showing the method when a class has had considerable experience and the song is not too long to be handled as a whole. Concert and individual work were both used. The song was about a woodpecker, so for work in pitch, intended principally for those whose pitch was not true, the whirr of the bird, or rather, the tapping, was imitated on various pitches. This furnished ear training as well. Then, using another melody, imaginary birds sat in imaginary trees, the class being the trees, and were rocked by the breeze. This was for cultivating a sense of rhythm and employs the whole body.

In the second class, I undertook to develop the rhythmic type two equal tones to one beat, the class never having read notes shorter than a beat. This was approached through a rote song. The method was different from that used in the first class, since the children had had more experience, and a test of their sense of tonality was included. The problem was figured out by ear and then presented to the eye with a blackboard picture and the ear and eye impressions connected. Drill followed this consisting of ear tests and the tapping of phrases containing the problem.

In the third class, I taught the intermediate tone sharp four, the class never having read with any tones outside the diatonic scale. As before, the problem was approached through the rote song, and the tonality test applied. The problem was analyzed by ear, the eye picture on the board connected up with the ear impression, comparison made with eight, seven, eight, and ear training given to strengthen the feeling for the new problem.

Then followed our conference in which we talked of a number of things, especially of points brought out in the first class,—the value of the outward expression of rhythm, the need of tone work, for ear and voice development, the range of songs for little children and so on.

Then we returned to the first class. Here we received our new rote song, brought out some of the slower members through individual singing, added more rhythm work, and did not leave the song until the class could sing it without the assistance of the teacher. Then we closed with some more songs we both knew, just to leave a friendly feeling.

In the second class, the new rhythm problem was reviewed, then material for sight reading supplied, and the class read at sight, using their new tool.

The same was true in the third class,—sharp four was renewed, and then the class employed the same in singing.

This comes a long way from the thousand words for which you asked, put I could not possibly spin so simple a story out to such length without discussing a whole lot of the underlying theory. I hope you will find it printable.

REPORT OF TEACHING

Mr. Geo. Oscar Bowen, Yonkers, N. Y.

In thinking over the matter of this demonstration before giving it before the members of the Supervisors' Conference, I realized that whatever I might do would be considered as a sample of the ideals and aims in public music in the East, inasmuch as all others who were to take a similar part were from the middle or far West. I do not wish it understood, however, that I set my work up as a sample of the work here in the East.

As a matter of fact, it was impossible for me to give a fair demonstra-

tion of the work which are my ideals. I realized that this was true before beginning and therefore made my plans to give a demonstration of teaching methods, of the manner of making the initial presentation of a principle in music to a class. For this reason I dealt quite largely with the purely theoretical side and the application of the principle taught to sight reading.

In a first class I undertook, and succeeded in some measure, to present them with the first application of their knowledge of tones to the staff notation.. I found a first grade class in the Fountain School which had unconsciously, both to themselves and their teachers, the tones of the scale. They had not used syllable names or any other means of learning the tones besides the singing of rote songs, so I was informed both by Mr. Beattie and the teacher in charge.

I taught the class the Italian syllables, by imitation at first, of course; followed this with the dictation of syllables, and the indications of numerals, the class responding with the proper syllable, and the correct pitch. I found the class quite ready for this work, though what I gave them should have covered the work of several days instead of several minutes. This I followed by the presentation of the component parts of the staff, i. e. lines, spaces, bars, double bar, and the G clef. Each of these points I brought out with the class. Then I presented them with what I am pleased to call a check-mark (X) to indicate the position of "Do" upon the staff, and proceeded to have them read from the staff with note heads. The reading, of course, was very elementary, but they did it, and the entire process was completed within fifteen minutes.

I gave this lesson because I found that the majority of people who were in my party did not attempt staff reading until the second year, while I believe that it is at least a half year of wasted time to leave it until the second grade.

I then went with my party of about fifteen people to a fourth grade and demonstrated a way of teaching a class to find "DO" from key signatures, and to know the key names. This lesson I gave thinking to show a reason why children should be taught something besides the ability to locate "Do", or "1" of the scale. Any plan which will enable them to locate "Do" is sufficient to enable them to sing from the printed page, and if our ultimate ends and aims of music in the schools is mere song singing, then it may be sufficient. But, is this, or should it be the ultimate aim? The answer from the West is in the affirmative, but in the East there is a tendency to give the child a training which will at least have some bearing upon his general musicianship, ,and look forward to the ultimate instrumental study which many of them will take up in later years. The ability to give the pitch name of the degree of the staff upon which "do" is located, to name the key, and to write the key signatures,, are not absolutely necessary to sight singing, but they are quite necessary to the musicianship which some of us have set up as an ideal for our school music.

In a fifth grade class I taught chromatics. The teacher told me that this class knew nothing about the chromatic tones or characters, except to recognize the sharp four. In a twenty-minute lesson I taught that class, which I am pleased to say, was one of the brightest and best groups of children that it has ever been my privilege to handle, how to recognize and

read from the staff, in any key, all of the five chromatic tones, using the sharp, the double sharp, or the cancel with the effect of a sharp, for the representation. After bringing out the several points in the lesson, i. e., teaching them how to sing all of the progressions, giving them the names of the chromatic tones, presenting them with the different characters for representation, I gave them several melodies upon the blackboard, in which I invariably included three or four, and sometimes all five of the chromatic tones. That they could read them accurately will be attested to by those who were present at the demonstration.

In this same fifth grade, and again in a fourth grade class, I gave some work from the music readers, both in one, and in two voice parts. We made some corrections in poor tone quality with individuals, and the class as a whole, and made an effort to give the class a little insight into the interpretation of the songs. We gave some sight reading with words, and some with syllables. On one or two occasions we found the classes stumbling on time problems, particularly the two equal tones to the beat, and the time represented by the dotted quarter and eighth notes. This we corrected in just a moment by reverting to the original principle by blackboard illustration.

My aim for all of this work was to make an effort to counteract if possible, to some degree, the teachings of certain sections which scout the idea of giving the child any information regarding music, except that which will enable him to sing songs at sight. The claim is made that there is not sufficient time for both, and if but one can be accomplished, drop the educational features and let the child sing. It is not necessary for me to say that I agree with this argument. I believe that it is possible to emphasize both parts of the work, and give the child a fair knowledge of both. As a matter of fact, I believe, from what I can gather by talking with others who have been over the situation carefully, that we in the East, who believe in devoting a certain amount of time to the theoretical side, are doing quite as much, and even more, along the line of sight reading, and song singing than many in the West who are committed wholly to the song method. The very fact that we give our children the ability to think for themselves, to recognize the symbols in staff notation and know what they stand for when they see them, enables them to read much more readily at sight and to understand what they are reading. If by one method it takes a man twenty minutes to teach a class of second or third grade children to sing the two equal tones to a beat, accurately, and another man can accomplish the same work in less than five minutes, who is taking the time from the class which might better be spent in reading songs?

The demonstration took place on Tuesday, and on Thursday I was asked to go to the same school again and give a demonstration before another group of teachers. This I did and took great pleasure in visiting the same classes for the purpose of reviewing the work of the preceding day, and to note with satisfaction that they had retained what I had taught them. This was not a surprise to me, but was to some of the observers. Any argument that I might set forth concerning methods of teaching could not possibly be so convincing as the proofs with which the children of Fountain Street School in Grand Rapids provided me.

Tuesday Afternoon

ADDRESSES AND DISCUSSIONS

The program was opened by the following musical numbers:

Quintette Op. 79	Klughardt
Quintette Op. 71	Beethoven

Grand Rapids Wood Wind Quintette

President Dykema:

In opening this tenth conference of the National Music Supervisors, I should like to say just one word in regard to our history: Ten years ago Mr. Philip C. Hayden, known to many of us as disseminator of news of music of the schools, was secretary of the music section of the N. E. A. of which Mrs. Frances E. Clark was president. At that time they felt the need of a greater opportunity for people who were interested in public school music to get together and talk over their problems. The two of them issued a call for people who were interested in that type of music to come for this discussion. They came, seventy-five of them, from seventeen states. I should be interested to know how many of the original seventy-five are here to day. Would you stand, those of you who are? (Those who arose included Mrs. Frances E. Clark, Mr. T. P. Giddings, Mr. E. B. Birge, Mr. C. H. Miller, Mr. C. H. Congdon, Mr. A. J. Gantvoort, Mr. P. C. Hayden, and a few others.)

From that time to this we have grown till we have an association that is attracting national attention, and is endeavoring to do national work. I shall have occasion to speak about that in a moment. In the meantime it gives me pleasure to introduce to you the one who will give the words of welcome, although we have already seen many acts of welcome.

The Superintendent of the city schools of Grand Rapids, Mr. W. A. Greeson.

Mr. Greeson's Welcome.

Ladies and gentlemen of the Conference: A quarter of a century ago—that sounds too long, I will change that—twenty-five years ago I was principal of Central High School in this city. The school then was in an old building, which has now been destroyed. At that time there was a youngster in the school whom we knew as "Peter". Now that he is enthroned as president of this great organization, I think we may call him "Peter the Great."

He was at that time, as you might know, knowing him as you do, an earnest, straight-forward, capable youngster. I have followed his career with great interest, and I am sure that we all know that he has fulfilled amply the promise he gave as a youngster in the Central High School. It is therefore a peculiar pleasure to me to welcome you to this city, because your President is "Peter." I can think of many reasons why I gladly welcome you to Grand Rapids.

I was speaking a while ago as the former principal of the Central

High School. I am now speaking as a representative of the Board of Education of the City of Grand Rapids. For some years the Board of Education has been very keenly alive to the importance of music in education, and while they could not furnish all the money that I wanted, and Mr. Beattie wanted, they have given what they could, not only of money, but of sympathy and cooperation.

I feel that we have made great progress in Grand Rapids. I feel also that we have not attained to the realization of our ambitions, and I welcome this Conference to Grand Rapids, feeling sure that we shall receive inspiration and help from your presence. I am hoping also, modestly, that we may be able to give you some hints as to the teaching of music in the public schools.

Now my next character will be as a member of the Teachers' Club of Grand Rapids—of which I am but a humble member. We have in Grand Rapids a very remarkable organization known as the Grand Rapids Teachers' Club. In that organization are nearly all the teachers in the public schools, with a very few exceptions. The Grand Rapids Teachers' Club appreciate all the good things in education and especially have they been keenly alive to the importance of music. It is largely through their help and co-operation that in Grand Rapids, we have been able to maintain each winter for the last four years a series of orchestral concerts, and we have brought to Grand Rapids, this little town, many of the great orchestras of the United States. That could not have been done without the co-operation and help of the Grand Rapids Teachers' Club.

Tonight you are going to hear a beautiful concert which is the offering of the Teachers' Club to you as a Conference. As a number of the Teachers' Club, I want to welcome you to Grand Rapids.

Now I am going to speak as Superintendent of Schools of the City of Grand Rapids—one of my many Protean characters this afternoon. As Superintendent of Schools, I think I have an adumbration of the meaning of music in education. I think also that the people of Grand Rapids are beginning to feel the importance of music in education. I feel that not only in Grand Rapids, but all over this country there is a great work for you to do to bring before the people a realization of the necessity of music as an integral part of any sound education.

Now music in the public schools is not a fad, nor is it a frill, nor is it simply an ornamental thing which has been introduced to tickle the fancy of the people. Music is an integral part, a necessary part of any sound education, and I welcome you to Grand Rapids hoping that you will help to impress that fact upon the people of Grand Rapids, thereby persuading them to continue their support of music in the public schools.

RESPONSE BY PRESIDENT PETER W. DYKEMA

Mr. Superintendent, Ladies and Gentlemen: The Music Supervisors' National Conference are happy to hear these warm words of welcome which confirm and reinforce the many courtesies that have already been extended to us. In these two opening days of our visit we have seen and received inspiration and helpful suggestions in such generous measure that we feel well repaid for coming here. Grand Rapids is a name that is a household word wherever fine furniture is held in esteem. Since coming here we have been astonished to learn of the numerous other world prod-

ucts which start from this enterprising city upon their journeys short and long to every part of the globe. But we are rejoiced to be confirmed in our belief that no commercial prosperity can long continue unless it rests upon a wise educational foundation. We have with increasing admiration learned to know a little more of that school system which has such a favorable reputation among the educators of this country, and we know now that Grand Rapids is the stamp not only of fine furniture but of fine citizenship.

We note that in your scheme of education the arts are well represented and that music especially is stressed as a means of producing a well rounded workman and citizen. We are proud of the achievements of your capable music supervisor and his able assistants and the principals and teachers who so willingly and effectively aid him. Grand Rapids may well prize Mr. John W. Beattie; he stands among the leaders of school music today. May the splendid work he has so broadly and securely developed in this city gather still more power, thus becoming not only of greater value to this community but to the country at large which from this time on will watch its devevlopments with keen interest.

DELIVERING THE MESSAGE OF MUSIC

PRESIDENT'S ADDRESS

PETER W. DYKEMA, Madison, Wis.

Possibly you are surprised at the size of this gathering of music supervisors. In spite of the threatened railroad strike, it gives promise of being the largest gathering we have had since this organization was formed ten years ago. What are the causes of this attendance? While gladly acknowledging the great drawing force of the reputation of the splendid music work in Grand Rapids, we are conscious that there are other contributing factors to this remarkable attendance. First of all, the supervisor is except in the larger places, almost isolated from other workers in the same sphere so that as the annual meetings become better known, supervisors will more and more come together for companionship and brotherhood. Secondly, no subject in the curriculum is growing more rapidly than music, so that every progressive teacher feels the need of new ideas and believes that our annual Conference is the best place to get them. Third, in the last few years our Conference has developed along such lines that it is now more than ever worthy of its name as a national organization. Without doubt, this meeting embraces representatives from the greatest number of states we have had. Moreover, I am glad to welcome publicly into our fellowship for the first time, some brother workers from our big neighbor to the north, Canada.

But, finally, I believe the most potent reason of all is found in the mental attitude which is more and more characterizing the individual supervisor. We are seeing ourselves in quite a new light. I do not refer merely to the spread of the community music idea, vital and important as that is; I refer rather to that more potent idea of which the community music movement is but one manifestation; this is the conception that music is an indispensable force in the development of that ideal democracy toward which are ever pointing our poets, our thinkers, our practical dreamers, in a word, our true leaders.

We music teachers ourselves, the bearers of the message of music, have not always seen clearly, stated fearlessly, and defended boldly the peculiar claims of our subject. For a long time the apologists for music in the schools have defended it by showing that it duplicated the contributions of the other subjects. We have heard that music is as entertaining as play, as disciplinary as mathematics; as precise as grammar, as informative as history, and so on down the list, and too frequently our teachers have been willing to stop when they have made music render these values. But we are coming to see that music can do more than merely duplicate other subjects. It can give its own unique contribution. It is doubtless the most powerful advocate of what might be called the idealistic point of view. For the great majority of children, music is probably of less utilitarian, less vocational value than any other subject in the curriculum. Even when saying this I am not forgetful that a splendid case may be made for music as a vocational subject in the schools. But I consider this rather a specialized point of view and one with which at this time I do not need to concern myself. At least, musicians need to emphasize much more than they have done, the claims of music in developing those powers, idealistic, spiritual, or whatever one may call them, which are the end and goal toward which all materialistic ends strive. The vocational subjects provide the means by which a person may later support himself. They give those absolutely necessary foundations of food, shelter, and raiment—the creature comforts—upon which all spiritual life must rest, but unless they are merely the foundation, they have been missed. Music is food for the higher nature.

In these days of terrible physical struggle, abroad and in our own land we are having more and more impressed upon us the utter futility of obtaining ultimate satisfactions in this world through the piling us of earthly possessions. There is no limit to external wants—the satisfying of one merely creates the demand for another more difficult to obtain. The man who first rejoices in the possession of a Ford runabout ere long dreams discontentedly over the comforts of a Packard closed car. We now see that the mystic of all ages has not been far from the truth in insisting that "the only solution for man's wants is in the exalting of the internal above the external". In the realm of the spirit only is complete satisfaction possible. In thus reiterating the idea that the kingdom of Heaven is within, there is no exaltation of poverty, no disregarding the proper needs of this body which is the temple of our spirit. We all need to be clothed, sheltered, and fed, but we also need to recognize that the satisfaction of these wants alone should not fill our horizon. Friendship, love, communion with the seers and prophets of all ages, contemplations of the beauties and duties of life, the formulating and seeking the spiritual ends of all life—these must find a much larger place in the life of every man.

These statements are not new to any of us; they represent the results of our thinking of our quiet and sane hours. But how do we live up to these ideals? Have we gone thru the developments that have characterized the growth of the modern doctor, for instance? The physician of today is no longer merely the pill-giver of a half century or less ago. He now realizes that his duty has not been done when he has given a dose of this or that drug. He treats not merely the physical ills of the individual under consideration. He studies what are the mental and emotional conditions connected therewith; he investigates not only the home, but the

neighborhood, and even the general civic surroundings. He becomes not only an individual dose-dispenser but a social worker. Have we passed beyond the pellet-period; are we still giving our precious gift in separate prescriptions designed to destroy little local areas of musical incompetency or illness? Or do we rather regard ourselves as physicians of souls who must consider the full life of our patients both during the few minutes they are with us in the schools and the hours they are away from us? Do we realize that music is preeminent as an example of the more than bread idea, that by its very failure to count as a tangible asset in getting the ordinary job, it is establishing itself with peculiar power in the proper kind of a curriculum—the one which makes not only a laborer but a man? Do we prize our subject because by it we are helping to establish that truest democracy, the democracy of internal achievement which is open to any one who strives for it? Do we in our teaching keep this point of view in mind and do we constantly stress the inspirational qualities of all art? Are we honestly proud of our subject? Can we sincerely say that we consider ourselves at least as important as any member of the teaching staff? Or do we really feel that we are merely tickling the fancies of our children with insignificant playthings which we are allowed to present only on the generous sufferance of kind hearted superintendents and boards of education?

The answers to these questions are to be found in two sources, the one, conditions outside of ourselves—the school organization, largely reflecting civic and national ideas; the other, within ourselves—what we are. The question of organization is receiving much attention from the officers of the Conference and needs no attention in this brief address. Let us now consider ourselves because in the end we largely determine what the school organization will do with music. Are we ourselves getting this power from music which we claim others should get from it? If we are not getting it is because we are not giving. We can have only those things that we share. Any lower attitude than this is unworthy of us permanently. On the other hand, it may be a point of view which we shall have to grow into. Our program this year stresses the need of more adequate training for the supervisor. This training must come along two lines—first, the stressing of the spiritual side of music, the realizing of the significance of our calling as bearers of themessage of music, the consecrating of our powers through withdrawing from the stress of the world or the plunging more deeply into it according as our individual natures demand it; secondly, the preparing of ourselves with an adequate foundation of musical and general knowledge and power. We are gaining along both lines. Father Finn, Mr. Chubb, and others will rightly stress the spiritual side of our calling: Superintendent Francis, Professors Miller and Stetson will be only three who will stress the necessity of more adequate intellectual training.

There have been remarkable changes in the process of training supervisors. Time was when anybody who had had a few lessons on the piano was considered capable of teaching music in the public schools. Then came the three or four week summer sessions conducted by publishing houses. Some normal schools, private institutions, and some of the universities began to introduce supervisor of music courses ranging from three months to three years in length. Now, while these continue—most of them

two, some one, and a few three years—the universities in some notable instances have established a four years' course leadiing to a degree, such as bachelor of music with a major in public school music. State Boards of education are slowly recognizing these forward strides in the preparation of supervisors. The standardization movement bearing with it the licensing of music teachers, is having a marked effect. Already it is impossible in certain sections of the country for anyone to obtain a license to teach and receive pay as a supervisor of music in a public school unless he has had training represented by a two years' course at a normal school or a university. It may not be long, so rapid is the spread of high school music, when states will require of supervisors of music the same qualifications that are made for teachers of other high school subjects—namely, three of four years of study beyond the high school.

A broader preparation means broader teaching because out of the fullness of the heart, the mouth speaketh. It may be difficult to see why psychology, literature, history, theory, composition, advanced methods of teaching and considerable skill in both singing and piano playing, to say nothing of a working knowledge of the instruments of the orchestra, will affect the supervisor who has only grade children to deal with. Nevertheless, even though the field of the supervisor *were not* broadened so as to include not only grade children but the pupils of the high school, the continuation school, and even the adults generally of a community as they are concerned in the various aspects of community music work, it would be quite essential for the best type of music teaching with any group to have a broad minded and broadly prepared teacher. Any instructor teaches not merely with his knowledge of his particular subject but with his whole experience. What he is influences all his teaching.

Now no small portion of what he is depends upon his environment, his associates. We may therefore for a moment consider the relation of the supervisor to our organization. We are learning to keep in touch with each other; our annual meetings and our Journal have done much to bind us together. But there is still much to be done. We are still largely individual isolated units. Every town and almost every supervisor plans a special course. Over and over, battles are fought concerning the introduction and retention of music in the schools, and music lovers are constantly seeking ammunition to carry on the fight. While there is undoubtedly much of value in this procedure, there is certainly much waste. For example, take the question of the amount of time given to music. Mr. Earhart's study showed great variations, although there was apparently something of a normal or standard amount in a majority of the towns. Undoubtedly, however, there are a large number of towns in which music is not receiving sufficient time in the school program. The ordinary supervisor may chafe under these conditions, and may strive to rectify them. For effective results he needs not only knowledge of conditions elsewhere which are similar to his—facts difficult to obtain—but he needs arguments which will influence school boards. Our organization should be furnishing these facts and arguments and reinforcing them by the influence of our national representative character. If, for example, the board of education and the superintendent were aware that a national organization such as ours had, after a careful study of conditions throughout the whole country, agreed in recommending as a conservative time allotment in the usual five

and a half hour a day school, one hundred minutes a week for each student from the kindergarten through the high school, the local supervisor would have a firm and helpful basis for pushing her claims.

There are numerous problems of this sort including questions ranging from the introduction of music into schools where at present there is none, to conditions under which private music lessons as elective work for high school pupils is permissible. In making the program for this year, a number of these topics have been scheduled either for addresses, general conferences, or round table discussions. But these should be regarded only as beginnings. From these meetings there should develop committees which should carry the work on through the year, formulating their investigations into recommendations, submitting these to some executive body of the conference who, when the time is ripe, should publish them with the authority of the national organization back of them. It is along this line that the National Education Association has been developing its different types of investigations. This idea has created and given the power to the National Department of Superintendence. It is along this line that we must develop if we are to cease being merely a mutual benefit association and to become an active force in national education. With our increased membership and increased dues, we shall have funds for carrying on needed investigations and for publishing and disseminating the results of our studies. The slogan for our Conference must be *"An all-year organization."* Up to this time we have excellently exemplified the proverb "charity begins at home". We have thriven on it. We are strong enough now to go on into the educational field at large. With our minds better trained, with our hearts more resolute, with our spirits higher, let us go forth to establish music, (still disinherited), in its rightful place in the education of the American nation. Believing that we have a message which our country needs, let us see that we deliver it.

At the conclusion of the President's address, the entire audience of supervisors and visiting teachers joined in singing "America", with a volume, enthusiasm, beauty of tone, and depth of interpretation which has seldom been heard.

President Dykema then introduced Mr. Chubb as follows: It was my privilege for a number of years to be associated with a remarkable teacher, one who better than anyone else I have ever known, seemed to realize in his own life the contributions which we are told art should make. In him the teacher of music, of art, of costuming, of dancing, and, of course, literature, which was his own chief love, found a responsive and sympathetic soul. His pupils in the English classes thought it quite the natural thing for him at any time to emphasize and illuminate the parts of a poem by singing, by dancing, or by sketching a picture. I have always felt that Mr. Chubb must have been favored by the presence of many good fairies at his christening. He would probably say that not at his christening but during his early life the fairies bestowed their gifts upon him. He, moreover, will probably show that these fairies were the surroundings of a sympathetic family, a group of neighbor's children who were untouched by the inroads of modern commercial civilization, and in general, all the surroundings of a simple and natural country life. I know that you have a great pleasure in store for you when I introduce Mr. Percival Chubb,

leader of the Ethical Society of St. Louis, author of authoritative books on festivals and pageants and the teaching of English, editor of several English classics, president of the Drama League, and in brief, an artist in many lines, who will speak to you on "Music as a Folk Art".

"MUSIC AS A FOLK ART"

PERCIVAL CHUBB, Leader Ethical Society, St. Louis, Mo.

Not being a musician, I ought to have some misgivings about speaking to this august gathering of musicians; but I am too anxious to put in my claim to be considered a co-worker with you to be greatly troubled by them. One of my designs upon you is to convince you that literature and music have suffered because they have dwelt apart in our schools. They are inseparable,—each needed by the other. We forget that the Muses were, in our sense of the word, "literary" folk for the most part. And if the specialists in music,—the art to which they give their name,—need to be reminded of this, much more do the specialists in literature need to be reminded that all literature is in its essence musical. MacDowell somewhere happily insists, as Wagner did, upon the importance of the fertilization of music by poetry. Equally important is the neglected fertilization of poetry by music, and of both of them by the dance,—the parent of rhythm. This cross-fertilization,— this ancient association of the arts, has been constant in the domain of folk art; and my plea for music as a folk art carries with it this insistence upon the old partnership. As the teacher of literature should be musicianly, so should the teacher of music be literary, and especially well versed in poetry. Lyric literature should be in the hands of the teacher and the department of music, rather than in those of the teacher and the department of English. For the folk, as for the great artist, a song has meant something sung, and the only proper treatment for a song is to sing it. No one would coldly recite the words of "For he's a Jolly good fellow," or "Should auld acquaintance." They belong together. I find it difficult to recite the words of "Sweet and Low" or "Drink to me only with thine eyes," for the same reason.

But here am I already afloat in the mid-stream of discussion. The immediate straight drive at a practical conclusion—one of first-rate importance—must not divert me from my intended path. I return to certain scruples as to my credentials, because they bear upon my theme. As a matter of fact, I was at first troubled enough to take some stock of my claims to be heard on the subject of music. There was comfort in the recollection that I was once a chorister of the *decani* side, in an English Church famed for its music, where I became practised in the best church music and reached my climax by singing in Bach's Passion Music in St. Paul's Cathedral; and, coming down to recent date, comfort in the fact that I was an active member of your President's High School chorus,—the best I have ever heard,—when I was not singing.

Then it occurred to me that my strongest ground was that which I was first taught to take by no less a person than the great French sculptor, Rodin. As it enforces the point of the interdependence of the arts, I will cite it. Visiting his studio many years ago in Paris, I became deeply interested in the great doors upon which he was at work (and still is, I believe) representing episodes in Dante's "Inferno". I was puzzled in regard to one feature. Summoning my courage and all my rules of French

grammar, I ventured to question the Master, who moved there among his guests. He answered courteously; and then looking at me quizzically, he asked, "Are you an artist?" I replied "No,"—perhaps a little dubiously, because I was bursting to be ranked as such on the score of my first modest literary performance just completed. He seemed to divine this, for he continued; "Have you never worked in any of the arts?" I then told him that I had just matriculated as an essayist, having written an Essay on Emerson, as a preface to a volume of selections which I had edited. Then he said what I have never forgotten, "Ah! That's enough. Young man, let me tell you that to work sincerely, no matter how humbly, in any one of the arts, is to get the key to them all." I have returned to that profound saying many a time. If we are not working at our art in that spirit, we are astray. Surely the key to the art of music should be very accessible to the worker in literature, and *vice versa*, because of the agelong association between the two arts.

But I finally concluded that my best and most pertinent qualification to speak to you on the educational aspects of music lies in the fact that my earliest education in both arts was by the folk method and by the use of folk-material. I was reared in my childhood on that great collection of folk music and folk lore which we commonly refer to as "Mother Goose," —the great folk-legacy of childhood; and instrumentation began for me, after the folk fashion, with a mastery of the kettle drum and the bones which I used in negro minstrelsy, later becoming proficient with the penny whistle. My maturer studies in the arts have convinced me that the folk-method of learning the arts by participating in them in this early fashion is the sound method; and that folk material in song and balladry, dance and drama, is the best material for the fundamental steps in literary and musical education. I have seen the results of attempting to employ other methods,—the formal methods of school instruction; and I have had much experience with the use of recently manufactured material. The material is adult; the method is bookish. All folk material is simple, the folk method bookless; learning by doing, participation based on imitation, learning by heart.

This difference was brought home thru a study of the kindergarten. The music and the verse shocked me. Froebel had profound insights; but his tunes and rhymes were abominations. In time this was recognized, and we began to turn out new tunes and words from the factory. They are too sophisticated (Example, Eleanor Smith's settings of Stevenson). Miss Patty Hill's criticism is that much of the early music for children was conceived rather as material for adults to sing to the children, and hence was too involved. Children seldom were so infected by this material that they picked it up unconsciously by ear and insisted on singing it by themselves, as they do with folk songs of the proper kind.

Before going further let me say to you that I speak as one who has been a sinner with the rest. Courtesy compels me to assume that none of you are sinners; but for the purpose of argument, I hope you are. There is nothing more discouraging for a reformer than to be continually calling the righteous to repentance. I dont want to waste my time and yours today in that sort of endeavor. But please remember that I am a repentant sinner in my own line, and my repentance is of long-standing, although it has reached an acute stage only in the past 6 years.

I have found much help in comparing the new order of things with that old folk order, in which I was in part nurtured. I have come to the conclusion that we have taken a wrong turn in the road following false methods adopted for other subjects. I must again be personal in developing this comparison. I remember that as a school-boy in England, attending a typical grammar school (much like that which Shakespeare attended at Stratford, or Sir Joshua Reynolds attended in Tavistock, in my native country) no heed was paid to the arts, and no instruction in language or composition. Art was an unknown subject, and so was music. We spoke and wrote more fluently and correctly, we read more, danced more, dramatized more, sang more—much more—than the children of today. Why? The reasons are many; but the chief reason was that these interests and activities were assumed to belong to life and to grow out of it; and we learned them in the ordinary course of living—reading books, browsing in our home libraries, because books were good fun; written to give pleasure and not to make trouble; singing, indoors and out, because it was as natural for human beings to sing as for the birds; dancing also, because all young things, human and animal, dance and play; rejoicing in games and charades, giving minstrel shows, circus exhibits, little pantomimes and pageants, and making puppet shows, all because it was a keen delight to do so. These things were part of the world of childhood in which we found ourselves.

To-day all these arts are subjects of study. They have got into books. We apply stern and intricate methods to them. We have to examine in them, mark on them, promote on them. So we inevitably strangle them. "All art is praise," says a great authority. It is based on admiration and joy. Faithful young people will do the required work; it is part of their servitude; but their hearts may not be won. You cannot club people into admirations. You cannot give courses in sunsets. Then why should you expect to be successful in giving courses which have their sole justification in developing an admiration for beautiful song, poetry, drama?

You will now suspect my critical bent. I shall have to be critical; but my intent is positive and constructive. My title may have led you to suspect me to assert in new ways the folk values,—social and community values—of music; an old story for you, oft told and driven home by your President. Instead, I am anxious to plead for a return to the folk way of approaching arts, and music in particular. In my own subject, literature, we have been corrupted, I hold, by the ideals and methods of the Renaissance. We have formalized; we have sworn by the book; we have isolated subjects from life and from one another.

The vision before me is that of the folk of earlier centuries; the unlettered people who built those wonders of beauty, the great cathedrals, folk-houses and guild houses; who developed the crafts whose products we treasure in our museums; who sang and chanted and danced to the songs and ballads; who made the great stories; who created the festivals and all their ritual. Remnants of their work lingered on into my boyhood. I know what the loss of all this folk art in song and dance, legend, story, ceremony, and drama, means. I believe we must get it back. Some of the beautiful material is being rescued before it is too late. Mr. Cecil Sharp is heaping up that treasure. We must go to school to that as Words-

worth and Scott did; as the great musicians have; as the Russian dancers have.

The first and most fundamental point is nearness to life. The tone test of the effectiveness of our modern pedagogocal methods, as against the old folk methods is the degree of power upon life. What is the outcome there of all our endeavors in the field of song and drama? What do people sing? What forms of musical art do they practise and patronize? What do they read in the way of story and the other forms of narrative? What kind of drama do they patronize or produce?

Most of us teachers have been victims, I believe, of certain illusions of the school room which leads us to apply as measures of success as the only tests that are worth applying. I have now been myself six years out of the school room, and I have been slowly recovering from a certain stupification of which I was a victim, due to the hum of the educational machine. Every teacher is of necessity fed to that big buzzing machine, and so tends to appraise education in terms, not of life and effective living, but in terms of class-room and school values. We forget that the pitilessly stern critic we have to meet is life. How have we affected and infected life?—that is the question. Put in other terms, what kind of patrons of the arts have we turned out? What life-long participation in any one have we promoted?

The crucial question raised by the change from the old regime which I knew to the new one of formal instruction is this: why do we try to teach the arts at all? The first part of the answer is to develop intelligent appreciation and lasting liking; the second part is, to promote some participation in the arts either vocationally or avocationally. The object of teaching drama, reading Shakespeare or what not, is to produce a good theatre-public and good amateur participants in folk-drama or festival. We must face the facts, and examine with merciless sincerity what we have done, as it stands revealed out there in the world, in our concert halls and theatres, in our behavior when we have our public holidays. We have ceased to sing at our work. But how much do we sing at our play? And what do we sing? Let me give you the example to which my mind continually recurs, because it brought the first sharp realization of the actual results of all our educational effort after I had given up class-room work.

It had been decided that St. Louis should have her first Community Christmas. The program had been arranged and all was in readiness. The giant tree stood ready surrounded by the platform on which the band was to play and the folk dances danced. The cathedral bells chimed out; the great star at the tree-top flashed into light; and a large chorus of school children led off with Christmas music. Then the crowd, under the vigorous lead of the band, began its singing. What did it sing? That had been provided for. No chances were to be taken. The words of six selected popular songs were thrown in large type on a conspicuous screen from which all could read them. The entire collection was sung,—more or less heartily; for the device was not conducive to great heartiness. Then, what? There was a pause. The dancers were not ready. The officer in charge of the program hurried to the bandmaster. It was agreed to try on other popular songs which the band could play from memory. "Annie Laurie" was a failure. We were discouraged. The enthusiasm *must* be maintained. We would score a full hit with "America."

The first verse went with a swing; the second lagged; the third sank to a hum.......that great audience did not know the words! The fourth stanza registered a shameful failure. Still the dancers tarried. We snatched at our last hope—"Dixie", and sang and resang it until the dancers appeared.

The crowd enjoyed the little Russian snow dance given by a group of children from a summer recreation center. Then there was another halt......... The second group of dancers tarried. There was only one thing to be done—more "Dixie!"—and yet more!

Then followed in quick succession the two main items in the program: two spirited folk-dances; one, by a group of Bohemians, an antique cooper's dance. The men dancers were gaily costumed in the national dress; and as they twined in and out, using their staves for arches, they evoked the first real tempest of applause from the great crowd. The second, another picturesque folk-dance by a group of Suabian men and women, was equally successful. ...... It would be wise, we thought, to close on the crest of this wave of delight; so the band played its strain of happy dismissal.

We are bound then, in the light of such happenings, to recognize our failure as a folk in the folk arts, music included. It is registered in our popular culture. I do not for a moment charge this failure in whole, or even in largest measure, to our schools. It is an open question how far the schools are responsible for not registering better results, considering all the time and effort we have been devoting to teaching children to sing and to participate in all the other arts with which the school deals. Far more important however, is it for us to face the practical question: What can the schools do to mend matters. What change of policy is needed?

The answer I shall give must be very general: We have failed in making intelligent patrons of the arts out of our children, and worse still, we have failed in making delighted participants out of them, in the first place because as I have just been saying we have not connected our instruction with life. The results have not passed over into life. Said Mr. Cecil Sharp to me not long ago: "What strikes me and surprises me is that you are not a singing people. You do not sing. With us every fellow when he takes his bath mornings, naturally breaks out into song." I had to admit that we had no bathroom lyricism worthy of the name.

To connect music,—and especially song—with life, means that we must stock our young people with the right usable songs. What are the right songs? Those which relate to the occasions and happenings of life, express the joys (and sometimes the sorrows which are the incidents of our human lot; convivial songs, in the best sense; commemorative songs, connecting with the seasons—the coming of spring and the flowers and birds, the joy of out-of-doors and the harvest; songs for the great festive occasions of the year, domestic celebrations, and civic and religious celebrations, and so on. These are the songs we repeat from year to year, as the folk did. Which we gradually amass and learn, as the folk did.

Do you say we *are* doing this? If we are, then why does life not resound with the singing? Why is not music a folk-art with us? There is something wrong somewhere: Just as there is something wrong with the parallel failure in our teaching of literature—story and drama. Singing should be with the young in school as with the folk in life, a hearty,

social, "convivial" thing; a refreshing, recreative thing; the songs should have simple charm, touches of beauty, a quickening liveliness and joyousness. After they leave school it should find its expression on the higher plane in choral societies, and musical organizations and in festivals of song.

I have no glib censure to pass. Have I not suffered my defeats in the attempt to make good literature a living, uplifting force in the lives of the young who have gone forth from my hands? Have I not labored with Palgrave's Golden Treasury of Songs and Lyrics, only to find some of my young charges relapsing into rag-time ditties? Have I not striven with Hawthorne and the great story-tellers, only to find them settled down to a steady diet of newspapers and cheap magazines? Have I not tried to develop a love of Shakespeare, only to face the fact that they swarmed to the comic opera and vaudeville show? Yes,—but then I think I see where the school treatment was wrong from the start, and the school diet unpalatable and indigestible.

Other reasons than that of remoteness from life have been implied in what I have already said; let me recall them. We have over-specialized; we have disjoined the arts that belong together—words from music, and both from gesture, ritual, drama. The singing game, the dance drama, the ballad, the processional, are all examples of this proper fusion of the arts. Then, it has lacked simplicity and child-like quality. Most of the material used was written for adults. I have found the same with music. Straining ambition has put these young people, by excessive drilling, through difficult operas, cantatas, oratorios. What comes of that? Not an abiding liking. Rather dislike. This is the equivalent to our endless worrying of the text of Shakespeare. It has been deadly. The same mistakes of leaping ambition have done great damage to school dramatics. We have chosen long and difficult plays calling for an expenditure of time and energy which has fretted everyone. To begin this policy in the kindergarten as I have remarked, is to discount our efforts from the start.

We need, then, in music, as in literature, a body of simple and beautiful material: songs suitable for daily, occasional and seasonal use; domestic, communal, commemorative, festal—for the outdoors and in. The best will have that folk flavor which has carried down the centuries the songs beloved of the people. There should be songs for birthdays and holidays; for parties and excursions; for the spring, at Easter and Maytime; for summer and harvest and mid-winter.

On this lovely wilding stock, the legacy of the folk, we may graft what choice kinds of cultivated art by the masters we will—so they be clear and intelligible.

About one characteristic of this folk art, I would add a word: it is often rude, even to coarseness, but it is not cheap, common, vulgar; and is therefore the best antidote to the vulgarity of our modern music-hall songs. I have heard this modern stuff drummed out occasionally by High School bands (just as I have seen vulgar farces given for dramatics); I know the violent drum-driven music used for social dances. And I wish to put on record here an experience I recently had at Washington in this connection. I attended the Patriotic Exercises held in the great home of the D. A. R. It was an occasion of solemnity and dignity. The President was there, and cabinet officers and ladies and gentlemen of distinction.

Banners were presented, and a medal; and there were orations. But punctuating these proceedings was the jauntiest, trashiest music by the official band. It jarred and disgusted me; but my neighbors did not mind. In what other great nation could that have happened? Teachers, here is our task!

We can only correct lapses of this sort by standardising taste in our schools. We must raise a new generation of music lovers. We shall succeed if we make music for our children not a subject in the curriculum, but a form of expression in their lives, their school life first, for the school is a form of life, a manner of living.

How many things I have left unsaid! I had to choose. Discarding the books as much as possible, let us make music a hearing rather than a seeing process. Sing to children to teach them to listen; sing with them to teach them the social joy of music. Do not allow the technical study of music to interfere with the first great object of music instruction—so filling children with lovely spontaneous music that they can not prevent themselves from making song an ever present part of their own lives.

Evening Program

Concert of Folk Songs by the Misses Dorothy, Rosalind and Cynthia Fuller in partial exemplification of Mr. Percival Chubb's address on Music as a Folk Art, by courtesy of the Grand Rapids Teachers' Club for the National Federation of Music Supervisors Tuesday Evening at 8:00 o'clock, March 20, 1917.

PROGRAM

The Singers' Apologie

The Song of the Play Actors....................Nottinghamshire

Children's Action Songs

Here Comes a Duke a-Riding ....Hampshire
When I was a Young Girl ....Dorset
London Bridge ....Hampshire
The Roman Soldiers ....Kent
Looby Loo ....Dorset

Love Songs, Fortunate and Unfortunate

The Maiden's Lament ....Ireland
Leezie Lindsay ....Scotland
O No John ....Somerset

INTERMISSION

Songs of Occupation

The Sheep Shearing ....Somerset
Dashing Away with the Smoothing Iron ....Somerset
The Husbandman and The Servingman ....Somerset
The Carter ....Somerset
Would You Know How Doth the Peasant ....Lancashire

Ballads

The Twa Sisters o'Binnorie ....Scotland
The Briery Bush ....Somerset
The Wraggle Taggle Gypsies ....Somerset

The Singers' Farewell

Brixham Town ....Devonshire

Third Day March 21, 1917

Morning Meeting

TOPIC:—INSTRUMENTAL MUSIC IN THE SCHOOLS

J. W. BEATTIE, Grand Rapids, Mich., Leader.

Program of Material Illustrative of Grand Rapids work in Instrumental Music

March..“De Moloy Commandery” ....Hall
Overture—“Mazeppa” ....Mahl
March—“St. Cecelia” ....Mrs. Heber Knott
(Grand Rapids Composer)

Band Selected from High School Pupils
Direction of Leo. E. Ruckle

“In the Homeland” ....Grieg
Frances Enos, violin
Dorothy Kern, violin
Lorraine Merriweather, viola
Hilda Bell, cello
Direction of Gertrude Fischer

“Prayer” (Der Freischutz) ....Weber
Oscar Kutchinski, 1st cornet
Richard Newton, 2nd cornet
Lloyd Norris, alto
Leo Spencer, trombone
Direction of Mr. Ruckle

“An Alpine Love Story” ....Petrie—Rose
Dorian Eberly, oboe
Theodore Lee, 1st clarinet
Gerhard Van Velsen, 2nd Clarinet
Clarence Klaasen, French horn
Clifford Ruckle, Bassoon
Direction of Mr. Ruckle

Selections from Mitchells Instruction Book for Violin, Number 1
Fifty children selected from the ten violin classes

Selections from Grutzmacher's Method for Violoncello
Violoncello class—Direction of Clare Hudson

Minuet from Trio in E flat ....Mozart
Alice Haralstad, piano — Emil Arnst, viola
Harlan Yarrington, violin
Direction of Mr. Moffitt

Selections illustrating the value of wind instruments in the orchestra
Central High School Orchestra
Direction of Mr. Beattie

Mr. Beattie:

President Dykema has me down on the program for fifty minutes, that is, he said he would permit me to occupy fifty minutes. It has seemed

probable to me that my share in the morning's program will be more helpful to you if I used my time with performances illlustrative of our work in Grand Rapids, rather than talking.

We believe very thoroughly that children in the grade schools should be offered instruction in instrumental music just as freely as they are given instruction in vocal music. The Board of Education has been willing to support this theory to the extent of supplying instructors. I have tried to be reasonable in my requests and the Board has seemed to appreciate that attitude. At any rate they have never turned me down.

The Board of Education does not furnish any instruments. Nevertheless we own quite a number of instruments which parents would be unlikely to purchase. These have been acquired gradually with money earned by the orchestras. Other instruments have been given up by persons interested in our work. We have four sets of drums, a set of tympani, three bass violins, two cellos, three violas, two clarinets, two French horns, an oboe, bassoon, tuba and several violins. These are distributed among several schools.

I have been interested recently in making a study of the number of homes where there are several children studying different instruments. I have been delighted to find that there are many homes in Grand Rapids where family orchestras are being developed as a result of our efforts in the schools.

In addition to the three band numbers which you have heard we are going to give you this morning several illustrations of the types of work we are doing. The first is

"In the Homeland" .... *Grieg*

This was, as you saw, played by a string quartet of ninth grade girls. We are trying to develop work of this kind in all our schools where there are orchestras. This number you have just heard was rehearsed under the direction of Miss Fischer, who is one of the violin teachers in the grade schools. The next number is

"Prayer" (Der Freischutz) .... *Weber*

A brass quartet of grade school boys. Mr. Ruckle tells me that all these boys began their work on an instrument last November. None of the boys has ever had any instruction except that given by Mr. Ruckle.

I am a great believer in the value of the woodwind instruments. Those instruments,, such as oboe, bassoon and French horn, which are rarely found in school orchestras, will do more to add color to the orchestral tone than many of you realize.

"An Alpine Love Story" .... *Petrie-Rose*

A wood-wind quintet of grade school boys. All of these boys have received their entire instruction from Mr. Ruckle in the schools.

At this time a group of 56 children walked onto the stage—each child carried a music stand, instruction book, and violin.

Mr. Beattie:

While these children are getting tuned up, I might say something in regard to their work. Two years ago, I asked Mr. Greeson if I might start some after school violin classes. The idea was to have ten or fifteen children in a class, and have the expense for the instructor pro-rated among the children. Sup't. Greeson said, "No, there is no reason why the

children should pay for such instruction. We will ask the Board of Education to furnish the instructors." Last spring, when the budget for school expense was being prepared, a sum of money was set aside for the work with after-school music classes.

We started the year with eleven classes and nearly 250 children enrolled. Two-thirds of that number have kept at the work, and this group on the stage, which will play for you in a minute, was made up by selecting the five best pupils from each class. The teachers of these classes are all private teachers in the city. They take the classes after school and devote two hours to each class per week. The class is, of course, divided into small groups, so that the children are not kept for the full period but come to the teacher at a stated time during the period for their lesson.

Several selections from Mitchell's, "The Public School Class Method for Violin, No. 1," published by Oliver Ditson were then played by the class of fifty-six children. The children concluded their exhibition by playing "America." The audience stood and sang as the children played.

Following this a group of three children gave a demonstration of class instruction on cello. They played from Kummer's "School for Violincello." Published by White-Smith.

PROBLEMS AND POSSIBILITIES IN THE DEVELOPMENT OF INSTRUMENTAL MUSIC

GLENN H. WOOD, Director of Music, Oakland, Cal.

Superintendent and Board of Education

The problem of securing instrumental instruction in the public schools is not a serious nor a difficult one to solve if the musical interest of the community is sufficiently great to warrant such an innovation. Co-operation must first be assured not only from the superintendent and the board of education, but also from the principals of the various schools as well, if such instruction is even to be worthy of recognition.

Unless the superintendent and the board of education are in sufficient sympathy with such a movement to recommend the necessary expenditure of money for the successful installation of such instruction, the task is doubly difficult. If this favorable condition does not exist, it is then necessary to endeavor to interest the superintendent and the members of the board of education and quietly but thoroughly educate them to an appreciation of the value of such instruction. The success of any instruction in the school system depends largely upon the endorsement of the members of the board of education and of the superintendent. It is essential, then, not only to secure their co-operation and support, but moreover to be sure that they are able to appreciate the worth of such instruction as being one additional phase of modern education.

Teachers and Their Qualifications

Granting that the board of education is sufficiently interested to consider the addition of instrumental instruction in music in the schools, the next consideration is that of securing competent teachers. Many teachers who are successful in choral instruction feel that they are also qualified to drill either a band or an orchestra. It is necessary to state here that the instrumental instruction in the public schools of America will never

be successfully conducted until it is placed in the hands of teachers who are capable and skillful instrumental performers. No amount of enthusiasm on the part of a teacher nor the ability to lead well will overcome the handicap of not being able to perform personally upon some instrument that is used in these organizations.

The most successful work is done by teachers qualified to instruct on all instruments of band and orchestra. Now this may seem like an impossible feat. However, for those who are able to perform on a violin it is not a difficult matter to acquire a correct if not a facile technique on the viola, cello, and string bass. If one plays the clarinet, the most difficult of all reed instruments to finger, he can soon acquire a reasonable amount of technique on the flute, oboe, bassoon, and saxophone. To any one playing the cornet, the fingering of all other brass instruments with the exception of the French horn is identical. The trombone is the only other instrument presenting a difficult and different plan of producing the intervals of the scale. While it may be said that no one person can ever become proficient in playing all instruments, any person qualified to play one instrument can easily learn to play some instrument of the string, brass, and reed families. With such an equipment, then, these teachers can, as a rule, create a keener interest on the part of the average student than can the expert upon one instrument alone. It has been found that teachers qualified to carry out the plan suggested above can also interest more students in instrumental study than can the private teachers. It is essential, then, to employ teachers who have the ability to perform on more than one instrument. The next best is the teacher who can play one instrument, preferably the violin for the orchestra, and the cornet for the band. Now these teachers, with a little patience on their part, can soon learn enough of the technique and the fingering of all the brass and reed instruments to give pupils a correct start. Only when teachers are qualified to correct the fingering and show pupils how to play certain passages, will the instrumental work ever be successfully conducted.

Leaders

Another qualification demanded of a good teacher is that he must be a strong leader of groups of children. Many teachers have the triple qualifications of instrumental technique and yet are not strong ensemble leaders. Careful leaders are essential, particularly in the work of the elementary schools and even more so in the high schools. By leaders are meant such teachers as have the ability *to weld* the *rhythmical playing* of thirty-five or forty individuals so that there is uniform performance, to *give cues* with such certainty that the students themselves are conscious that the instructor knows *when* they should play, *how* they should play and that he will insist upon their playing their parts not only correctly, but with some conception of music interpretation.

Tuning

Frequently teachers in charge of organizations do not understand tuning of brass and reed instrument and permit pupils to play on without changing the slides to keep the instrument in tune. It looks so easy, to the casual observer, to see a teacher drilling a band or orchestra that they frequently imagine that it is an easy thing to do, not appreciating that it is the most difficult phase of music teachers are called upon to instruct,

and for this reason it should always be detailed to experts. If teachers would take the time to mark frequent fingering on the parts, the pupills would make fewer mistakes in intonation. In the hands of competent teachers, a rehearsal is a remarkable bit of education and in the hands of others it is distinctly a waste of time.

There is no study in the curriculum of any school, be it grade or high, that offers so fine an opportunity for concentration as the subject of music. The discipiline of a well conducted rehearsal is as efficient in its results as military training. If the teacher is a leader and challenges all mistakes, the pupils learn to respect not only the authority and discipline of the rehearsal itself, but have an even greater respect for music because of the rigid discipline that is compulsory to produce good ensemble playing. So it is necessary to secure as instructors those teachers who are qualified to play at least one instrument and who are, moreover, gifted with the power of leadership.

Instruments Supplied by the Board of Education

In recent years the interest in instrumental music in the public schools has extended throughout nearly all of the larger cities. It was formerly necessary to accept pupils who had received only private training on the solo instruments and this produced a dearth of instrumentation in the school organization. In other words, the pupils presenting themselves for membership in the orchestras could play only the solo instruments, such as the violin, cornet, clarinet, trombone, cello, and flute. In order, then, that the ensemble might be developed, it became necessary to assign certain pupils to secondary parts. Many pupils feel that they are being discriminated against when asked to play second violin, for their teachers have faithfully told them that they were wonderful performers and that they will eventually become Fritz Kreislers and Ysayes. This common fault of having too many solo instruments and so few secondary instruments necessitates the purchase of such instruments as will complete the instrumentation of the band and orchestra. These instruments should be supplied by the Board of Education. It is as legitimate an expenditure of public money to supply instruments for the music department as it is to supply equipment for a machine shop, a domestic science department or a chemical laboratory.

The instruments necessary in the grade schoools are half size string basses, half and three-quarter size cellos, tubas, mellophones, drums, oboes, and bassoons. In the high schools add the violas and French horns to the list given for the grade schools and your equipment is complete. While a few of the violas are in the grade school orchestras of Oakland, this instrument receives more attention in the high schools, for by that time the individual violin pupil is sufficiently advanced to be transferred to the viola and he is then better able to master the intricacies of a new clef. The French horn is too difficult an instrument for beginners to learn and it needs an expert teacher, so the pupil who has played the mellophone or cornet is better qualified to study the French horn. Few school systems possess oboes and bassoons in the elementary organizations, for they are quite expensive and very few parents know enough about them to appreciate their worth. Whenever it is possible, pupils in Oakland are started on either the oboe or the bassoon, but we frankly admit that the results

obtained are not always satisfactory. It requires considerable practice and long experience to be able to manipulate the reed of the oboe and bassoon, so we rarely expect much proficiency on these instruments from the pupils of the grade schools.

Rehearsals

It is almost impossible to secure frequent rehearsals and lessons in the elementary schools, as the instructors visit the buildings only once a week. There is always a daily rehearsal in the high schools preferably given during school hours. Upon the frequency of the rehearsals depends the success of instrumental instruction.

Ensemble

The welding of the ensemble cannot be developed except through practice in playing together, for it is during rehearsal that the pupil becomes accustomed to hear the various rhythms and melodies played by other instruments, to make retards, to hold pauses, to attack together, and to change tempo with ease and certainty.

Lessons During School Hours

In Oakland, it has been possible to secure a concession from principals and teachers permitting the pupils to take their instrumental lessons during school hours, being excused from recitations once a week for fifteen or twenty minutes. Under this plan only is it possible for the teacher to give full service to a school department and employ all of his time from 8:00 A. M. to 3:00 or 4:00 P. M. in teaching. The grade school rehearsals are generally held either in the morning or at noon, while in the high school it depends upon the assignments of the major periods. Four of the high school organizations rehearse before school and during the noon period. The fifth high school rehearses during school hours, as a regular study. It isn't needless to say that the best work that is done in the department is done in the fifth high school.

Regularity

The regularity of rehearsals brings to the attention of the leader those pupils that need assistance and gives opportunity to develop style and finish. The high school band of forty boys, average age seventeen years, rehearsing every day for forty-five minutes, plays better than the University of California Band of fifty-five young men, average age twenty years, rehearsing once a week for one hour, and both organizations are under the direction of the same teacher.

So successful work in any line cannot be accomplished unless there is some regularity and frequence to both lessons and rehearsals.

In order to introduce vitality into the lesson period, it is essential that the teacher should insist upon systematic practice of scales, upon the holding of long tones to develop breath control, upon acquiring dexterity of technique. Added to this, of course, are the studies in the instruction book, the pieces the organizations are playing, as well as solo numbers. Where teachers are exacting, but patient as well, the pupils make rapid progress. Again the subject settles itself in the qualifications of the teacher and his ability to produce and accomplish results.

Instrumentation

In order to acquire full instrumentation, it is frequently worth while to encourage pupils to transfer from one instrument to another that they may have a larger acquaintance with different instruments and yet be able to convince them that they are not losing the training they have had on one instrument in studying the technique of another. It is easy for the cornet player to transfer to the French horn, the saxophone player to the bassoon, the clarinet of flute players to the oboe, the violin player to the viola, and many other changes can frequently be accomplished when pupils have had previous instrumental training. Piano pupils and tuba players often like to take up the string bass and frequently a student will learn the tuba, string bass, and bassoon, for if he has acquired the ability to play one instrument, it is easy to learn another one, and he rarely regrets the time spent in acquiring this knowledge. The efficiency of any instruction in the public schools depends upon whether or not the student himself is made to feel that he has really gained some information that is positive and definite. We all like to do things that we can do well, and as pupils can be taught to play well it is only natural that they should enjoy playing. The only complaints that we hear against instrumental instruction in the schools, or against any subject in fact, are from those persons who have never acquired any distinct ability to do anything reasonably well.

To observe the problems in concrete, then, it is necessary to have the support of the superintendent and of the board of education, to secure able teachers, frequent rehearsals, and frequent lessons, to infuse vitality into the lesson and daily rehearsal, to supply instruments at public expense, to transfer pupils from one instrument to another, to secure complete instrumentation, and to give free lessons during school hours.

No matter if the problem of securing instrumental instruction seems to be insurmountable, the work itself is so effective that no amount of discouragement can ever offset the real value of such instruction. While it does not reach as many students as the choral work, it is more vital than any other study contained in the curriculum that demands public performance in order to estimate its educational value.

HELPING THE SCHOOL ORCHESTRA TO BE SUCCESSFUL

R. C. SLOANE, Richmond, Ind.

The School Orchestra movement has probably met with more discouragements than any other department of education.

People, at first, thought it impossible for children of grammar and high school age to acquire enough technique to play the violin and other orchestral instruments well enough to take part in an orchestra.

The playing profession frowned upon such an organization, made light of the earnest attempts of the schools and the faithful few, and in many cases, do so today though they are grossly ignorant of the development of the school orchestra and its bright future.

The school officials did not help. They did not know that a "fiddle in the hands of a child" means as much to the education of that child as any other subject, providing the child's training is directed by a suitable teacher. On the other hand they did not furnish musical instruments of certain kinds needed in the building of an orchestra nor did they give credits for work done as in other subjects.

The parents were reluctant about buying instruments, putting their money into an instrument which was not sure of returns.

Last of all the supervisors of music were at sea, some of them were trained orchestral performers while others did not know much about orchestral instruments. Those who could go ahead with the movement were handicapped on all sides. The most serious problem was, perhaps, in securing proper music for a young orchestra, easy, yet good.

How time has changed in the twenty years past! Yet, as we look at the development of instrumental music in the schools from all angles, we see much to do and we must help one another.

The speaker owes much to a little school orchestra in Ohio which was organized many years ago, perhaps one of the first school orchestras, and realizes the many hardships which were encountered on the sea of orchestral development.

My message to you this morning is not merely to relate history, but to tell you of some of the outstanding things which have helped me in making my work with young people successful. To begin an orchestral movement, a great spirit of musical interest must be aroused in the hearts of the children, parents and school officials. They must co-operate with the supervisor who must know how to organize and conduct an orchestra. Such a leader should at least play the violin or piano, know the history of the orchestra, the various instruments, how to tune each, what voice they have and what kind of a part they play. He must be the heart of the orchestra and must have the full confidence of his young players.

The private or studio teacher is a great factor in helping the school orchestra succeed. He must work hand in hand with the supervisor or director, should know what music the orchestra is studying and see to it that his pupils take their music to him for instruction. He should keep the supervisor posted as to the advancement of pupils and attend rehearsals, whenever convenient, to see what is being done. This will give him an opportunity to compare the work of his pupils with those of other teachers. Let us then look upon the private teacher as a vital force in the success of our school orchestras.

The pupils must help by taking regular weekly lessons, conscientiously practicing at home and by giving undivided attention to the director at rehearsals. They must understand that they are a part of a whole unit, and if the part which they play is not correct, they will destroy the work of others. A comparison which I often use to illustrate this point is "A class of children are having their pictures taken and when the proof is ready we find that one child has moved, thereby spoiling the picture".

The instruments must be kept clean and in good condition, the violin bows, full of hair, the instruments free from rosin dust, the brass instruments polished. These things, while they seem trifling, are important. Pupils must not under any consideration tamper with one another's instruments. This is a very bad habit of which most amateur orchestras are guilty, and it should not be tolerated.

The school authorities must do their part by providing music and such instruments as are needed which are not solo or home instruments, bassoons, basses, oboes, trombones, violas, French horns, drums, etc. These

instruments when provided by the school are to be loaned to pupils under contract so that the school's interest in its property may be protected against loss.

The publishing houses and composers of orchestra music play a very important part in this movement. In the earlier days, simplified editions of large works published. Experience has taught me this lesson, *never* use such publications because they do more harm than good. If your orchestras cannot play the original scores of the larger works, select something they can play. Most publishing houses have heard the cry from thousands of young orchestras for *good, easy* music and have come to the front and are doing their part by giving us such publications. I would not tolerate popular music in any shape or form. What would you think of your English teachers if they were to allow their classes to study popular novels? If such a condition is good for one it must be for the other.

Give as many orchestra concerts as you can during the school year. This keeps public interest aroused. Always select a pleasing program, no matter how easy the music, see that it is well played.

This brings me to the climax of my address. After considerable observation and study we have outlined and tested a plan by which a school may give credits toward graduation for orchestral work done.

In Richmond we have two school orchestras of sixty players each, one in the Junior high School, the other in the high school. These orchestras are closely related. The pupils who enter the Junior orchestra hope some day to be promoted to the high school orchestra. The same private teachers instruct both classes, also a large class of boys and girls below the eleventh grade who in time will take their place in the Junior orchestra.

Pupils who enter the Junior orchestra must be able to play in nine keys, produce a good singing tone and be recommended by their private teachers and sign this enrollment card (READ CARD). This card is used by both orchestras and signed at the beginning of each school year. At the end of each semester (18 weeks) we send a report card to the private teacher who grades the pupils upon the following basis. (READ TEACHER'S REPORT). This grade averaged with the orchestra conduct grade determines the number of credit hours and credit points the pupil has earned.

The rules governing the credit system are as follows: (READ CREDIT SYSTEM.)

RICHMOND HIGH SCHOOL, RICHMOND. INDIANA.

Orchestra Credits

Inasmuch as a pupil may earn and use eight credits in music to graduate from the R. H. S. four of this amount may be from orchestra work. Thereby placing same as regular school subject. The following rules must be observed.

I. All pupils in the Garfield orchestra must take lessons regularly, once a week during the school year from some recognized private teacher whose ability as a teacher may be judged by the school authorities.

II. Pupils in the high school orchestra must take lessons for the first two (2) years of their membership period.

III. At the completion of the first two years of study said pupil may

apply to the principal of the school for an efficiency examination, and if successful, may remain in the high school orchestra, providing his playing is up to standard and he observes rules of school and orchestra, thereby earning maximum credit of .3 per term. Provided further that said pupil is to be graded on his work and may receive only .2 per term.

IV. Or—if pupil desires to continue study as per Rule I for the last *two* years, said pupil is to receive full credit .5 per term.

V. When a pupil becomes a member of the Richmond High School orchestra his work is not completed until he has graduated from said school. If, however, pupil should discontinue or be expelled from the orchestra, said pupil is to lose orchestra credits previously earned.

VI. Efficiency examination is to be continued by the supervisor of music or his assistant at the beginning of each school year and to consist of the following:

1 Sight reading
2 Scale playing from memory
3 Tone production
4 Position
5 Knowledge of theory of music and the instrument which the player uses.

VII. Pupils who have passed the efficiency test will receive either .2 or .3.

Regular studio pupils to receive their grade upon this scale, .3 .4 and .5. The grade is to be determined by the report from private teacher and orchestra conduct grade.

A studio pupil whose grade falls below (3) or examination pupil below .2 will be dismissed from the orchestra or placed upon probation for a period of six weeks. If at the end of this period said pupil has not improved he is to receive no credit for previous orchestra work.

hr.	pt.
.5—2.5	2.5
.4—2	2
.3—1.5	1.5
.2—1	1

VIII. This ruling is for first chair pupils only, as second chair pupils if they were to take said examination and pass would forfeit their rights to advance in due time to the first chairs of their division of the orchestra.

Signed
Ralph C. Sloane, Supr. Music.

ORCHESTRA ENROLLMENT CARD

Name .... Phone............
Address ....
Orchestra .... Instrument...................
Do you use a school instrument?...................................
Position in Orchestra 1st. ....2nd. ....
Teacher's Name ....Phone.........
Remarks ....
....
Parent's or Guardian's Signature..................................
Teacher's Signature ....

IMPORTANT

It is a privilege to be a member of the Richmond School Orchestras, which have through hard and systematic work reached a very high state of perfection.

In order to maintain this standard it is necessary for all orchestra pupils (unless excused for some good reason) to take private weekly lessons upon the orchestral instrument, from some RECOGNIZED and CAPABLE TEACHER of said instrument. Also to attend all reheasals, concerts, exercises and to study the orchestra music at home.

If you are willing to "measure up" to these requirements fill in the reverse side and return to Mr. Sloane.

F. G. Pickell, High School
N. C. Heironimus, Garfield

TO THE STUDIO TEACHER

M ....
Pupil ....
Orchestra ....
Instrument ....
1. Has the pupil made good progress and taken interest in the work? (50 per cent) ....
....
....
2. How many lessons has this Pupil taken this term? (30p. c.)
....
(Deduct three for every lesson missed without good excuse)
3. Does this pupil take his or her orchestra music to you for instruction? (20 per cent) ....
....
....
4. On the basis of 100 per cent give this pupil a grade....p. c.

Ralph C. Sloane, Sup'r. of School Music.
Edna Marlatt, Ass't. Sup'r.

POSSIBILITIES IN THE DEVELOPMENT OF INSTRUMENTAL MUSIC IN THE SCHOOLS

ANTON H. EMBS, New Albany, Ind.

It has been assigned to me to discuss, briefly, the "Posibilities in the Development of Instrumental Music in the Schools" of the medium and smaller sized cities. I have interpreted the word "possibilities" to mean the method or system by which such development may be successfully accomplished and have outlined this paper accordingly. Let us, therefore, consider the case from the standpoint of the Supervisor in a city of 30,000 or less, who, like a good general, before proceeding to the attack, examines the "field" carefully in order that his campaign may be directed with intelligence, efficiency and thoroness.

It is the policy of the manufacturers and wholesale business houses, when "opening up" new territory, to first "prepare" that particular district by advertising in various forms, which is calculated to arouse the interest (and curiosity) of the trade concerning the article which they offer for

sale. This preliminary campaign is to be followed up by the advent of the "Knight of the Grip" with his sample case, in the several trade centers of that district, who enlists the *retail merchants* in the service who, in their turn, extend the canvass to their customers,—and, thus, the territory has been effectually developed.

Now, the Supervisor can profitably employ the policy of the manufacturing and wholesale business firms, aforementioned and model his plan of procedure after the one adopted by them. His aim is to introduce and develop instrumental music in the Schools from, let us say, Grades three to the High School inclusive, which constitutes his territory. The grade teachers serve in the same capacity as the retail merchants and the pupils represent the trade.

For the first step, in the campaign, the supervisor will take the grade teachers and their principals into his confidence and outline to them, in full, the plans and purposes of the movement about to be inaugurated in their midst. This step is necessary to the complete success of the undertaking since, owing to their influence over the children with whom they come in *daily* contact, their co-operation will mean much in the saving of time for the supervisor and in stirring up enthusiasm.

Having prepared the teachers for their part in the work, which can be considered one of the forms of advertising to be employed, it is well, at this time, to hint to the general public, thru the columns of the local papers, of the plans about to be put into operation in the schools and the advantages to the parents. The newspapers in the smaller communities are usually quite willing to print, without charge, any articles which school officials may submit, provided of course, they have a news value, and in this way the interest of the parents may be touched before that of the children is stirred.

It is well to bear in mind that, in this day and age, a good publicity department is an absolute necessity to any enterprise and many a worthy cause has failed because of the lack of sufficient advertising. Therefore the Supervisor will neglect no opportunity to keep the community well informed concerning the progress of the Department of Music in the Public Schools.

If the High School supports an orchestra or a band or both, of sufficient proportions and ability, a tour of the grade schools for the purpose of giving exhibition programs will be a most effective means of arousing enthusiasm. To these programs the patrons of the school as well as the children should be invited.

The time has now arrived for the supervisor or assistants, if there be any, to make a room to room canvass in the role of the "Knight of the Grip" armed with his sample case containing pictures of the various orchestra instruments, (which may be clipped from some manufacturer's catalog), several victrola records exploiting the tone quality and possibilities of these instruments; and several large sized pictures of any of the famous symphony orchestras of the United States.

In the rooms, before the children, the supervisor will lecture in language to suit the grade, on the subject of Orchestras and Orchestral instruments, showing pictures of each instrument in turn and illustrating its tone by means of the victrola records. The pictures of the symphony orchestra will serve to impress upon them the importance of music in the

world which they are being prepared to enter and will also illustrate the position of each instrument iin the orchestra ensemble.

The supervisor will close the talk with a full explanation of the splendid opportunities about to be offered and an earnest appeal to the pupils to take full advantage thereof. It is well to lay particular stress on those instruments which are more difficult to play and more rarely to be found in the hands of amateurs.

The matter now passes into the hands of the grade teachers who "follow up" the talk of the supervisor with more intimate daily talks, drawing out the children by questions concerning their preferences and rendering advice or opinions which may help them to make a choice of instruments. Unless a little judicious and tactful advice be distributed, the boys are likely all to select the cornet or drum as their preference and the girls to vote unanimously in favor of the violin.

The next step is, of course, the call for the names of all who have decided to enroll in the classes and to which section, string or wind, they are to be assigned. This part of the work should be handled, in each building, by the principal thru the teachers and the reports turned over to the supervisor who will distribute the pupils to their several classes.

Since there will most probably be a majority of violin students, it will be possible to have specialists on that instrument, as teachers, but for the benefit of the few who may choose bass viol, cello or viola, one of the teachers should be able to teach all of the stringed instruments.

(It may be stated just here, that I am assuming a case where the Board of Education cannot afford to employ teachers on salary to do this work free of charge. In such a case the supervisor must find capable teachers who can give such instruction in classes of ten or more, each pupil paying a small fee per lesson, the total sum averaging about the usual rate for private lessons which that teacher would demand.)

Now the class method of instrumental instruction is not ideal, but is simply a means to an end. Many parents either can not afford or are disinclined to pay a large price to a good teacher for private lessons merely to ascertain if their children have talent or a taste for music; nor could a good teacher afford to accept such pupils for less than the regular rates merely to enable these children to find themselves. But with the arrangement just mentioned, the better teachers in the community can afford to take an interest in the work, since many of the children upon becoming deeply interested will leave the classes to take private instruction, usually with the same teacher. On the other hand, those who are less talented or cannot afford the private work, may continue to have the benefit of the best instruction, altho the progress will necessarily be much less rapid.

In the case of the classes for wind instruments the same conditions will prevail as in the case of the bass viol, cello, and viola groups,—too few of each to make a separate class—hence, it will be necessary to find a teacher who is thoroly acquainted with and is able to teach each of the wind and percussion instruments. This teacher should be a good performer upon at least one of the instruments, preferably the cornet, but must, in any event, be a thoro musician with ideals and tastes above the average.

These classes because of the variety of instrumentation are in reality small bands and a system of instruction may be used in which the same

exercises written in the proper key for each of the transposing instruments can be played in unison, a first step to ensemble playing. In this system, the pupils are led, by degrees, from simple exercises in unison to more difficult, harmonized melodies, the parts being so arranged that each player is given experience in that form or mode of writing for which his instrument is peculiarly adapted. It goes without saying that these classes have full attendance most of the time.

The classes having been organized and instruction begun, the supervisor will make regular trips of inspection in order to assist the teachers with whatever difficulties may arise, but, more particularly to impress the pupils with the fact that the work is under the direction of the Public School Music Department and therefore to be taken seriously as a part of their general education. It is the personal touch here, as elsewhere, that counts most heavily, for the pupils may be inspired to work more faithfully if they have an incentive; and the properly administered praise or rebuke of the supervisor on these rounds of inspection will serve as a spur to quicken their effects during the period between visits.

The greatest stimulus of all is the anticipation of a public performance and as soon as the members of the various classes are capable, they should be allowed to play before small gatherings of their friends and relatives. The program may consist of ensemble members by each of the classes in turn, little solos by the more talented and several numbers in which the entire body of performers take part. These last may be arranged by having the violins play the melody to some of the little pieces which the wind section play, with the piano for general "filling in" purposes. America thus rendered is a good closing number, and, in these days of awakening patriotism, very appropriate.

After the classes have reached a state of proficiency which will enable them to play, at sight, music of moderate difficulty, the organization of orchestras should be attempted. The best players from string and wind sections are therefore selected and divided into groups more consideration being given to the balance of the parts than to the mere numbers. Those who lack the qualifications necessary to enter at this time should be brought to the proper state as soon as possible and admitted when they have qualified.

In the course of time, those pupils who were influenced to take up the study of their instrument from some impulse which they misinterpreted as real interest, will one by one tire of the effort and drop out of the classes, leaving those who sincerely wish to work, in undisturbed possession of the field. These discouraged members will at some future time, make good listeners since they will realize, from experience, the amount of hard work that is required to produce even a moderately good performer and will accord to those who have persevered, a deeper appreciation on that account.

There will be quite a few good soloists developed from the number of those who remain, probably one or two very talented and capable players and the rest will not rise above mediocrity. Nevertheless, all will have acquired a much greater appreciation of, and a deeper love for the Art than might otherwise have been the case.

In order to give those pupils in the 8th grade and High School that training which will equip them to enter the High School Orchestra, a special organization should be formed which would serve as a reserve corps from

which to recruit the members needed to replace those who are graduated each term. In this way, the standard of efficiency in the High School Orchestra may be raised to a much higher plane and the pupils will have passed thru three stages of development, each stage demanding more proficiency than the preceding one.

In conclusion I would say that the suggestions contained in this rather meagre outline of plans for instrumental development, are not based upon mere theory but were put to a practical test in New Albany, Indiana, last year and were found to be thoroly practical in every detail.

The campaign was begun in February 1916; about 150 pupils out of a total enrollment of 3500, responded to the call; 50 of which formed the wind instrument class. The remaining 100 entered the violin section. Three teachers were employed, the classes being held before and after school hours. Each class received two lessons per week and some found time to get an extra hour.

In June, at the close of the school year, such good work had been accomplished by the teachers, that a program of the character before mentioned was rendered, the Public at large being invited to attend. The work was continued thruout the summer months and with the opening of the schools in the autumn, three grade orchestras were organized, not with full instrumentation to be sure, but fairly well filled.

Conditions over which the school system had no control, have somewhat retarded the growth of these young organizations but with encouragement and, above all else, system, they will, in the future, be able to give a good account of themselves.

The possibilities in the Development of Instrumental Music in the Grades, therefore, are almost unlimited and, since the influence upon the other phases of music is so markedly beneficial, it should be given every attention necessary to bring it to a high state of efficiency.

POSSIBILITIES IN INSTRUMENTAL MUSIC

ARTHUR J. ABBOTT, Buffalo, N. Y.

In speaking of the possibilities of instrumental music as a factor in public education in large cities, it is, naturally the situation in my home city that I have in mind.

Buffalo has 65 grammar schools, some of them with a very large registration; a City Training or Normal School and 5 high schools. There is in the city, also a State Normal School with a registration of 600 students.

It has been my good fortune to teach and supervise music in public schools in country districts, small villages, places of 5,000 inhabitants, one of 15,000, another of 100,000 inhabitants and in my present position in Buffalo. In every place, small or large, from the village schools where, with fear and trembling I taught my first music lesson, up to the goodly city of Buffalo I have found the same great desire among young people to play an instrument and the same eagerness to unite with others in the formation of orchestra or band.

As a boy I walked miles for the privilege of playing violin in a country orchestra, and to play in the band or attend a singing school a mile walk was just a pleasant evening jaunt. As I longed for the ability to express myself through musical instruments and to be one in a musical community, and as many of you who are here today, as children, longed to express

yourselves, so do the children in our schools long to "come through" in instrumental music. I see myself in every child who comes to me with a violin or other instrument—I know what is in his mind, his longings and aspirations and he has me with him from the start.

A call was sent out to the boys and girls in the eighth and ninth grades who play orchestral instruments to meet me after school on a certain day and I asked them to bring their instruments. I wanted to explain to them the matter of Regents' credits possible for orchestral practice in the high schools and, incidentally to lay the foundation for a Grammar School Festival Orchestra.

There came a host of violins, several cellos, flutes, clarinets and cornets, and one trombone. With some of the children came their fathers or mothers. Just as we began playing four little black eyed chaps came trudging in lugging violins. The spokesman of the quartette informed me that they heard of the meeting through the older pupils and while they, themselves, were only in the fourth grade they wanted to get into the orchestra "if it wasn't too late". I explained that the meeting was for eighth and ninth grade pupils only, but had them sit down and gave them a first violin book to look over. Those four little fellows remained after the rehearsal and told me they had attended the free concerts given by our excellent municipal orchestra, that they had been playing for more than two years and felt that they *must* have an opportunity to play in an orchestra.

One of the cello players who was present that day, a quiet, serious appearing boy told me he had not been able to take lessons because of the expense; what he had accomplished was the result of his own effort and the encouragement given by his parents who are anxious for him to succeed. I talked with the fathers and mothers who had come to the meeting with their children; each was anxious to do every thing possible that their children might succeed along the line of inistrumental music.

After all had gone I sat for a long time thinking of the wonderful possibilities in instrumental music that might be realized for the children in the public schools of Buffalo—class lessons upon every instrument of the symphonic orchestra; orchestras in every school; school bands in various sections of the city; string quartettes and quintettes; cornet quartettes and brass sextettes; wood-wind ensemble; all of these activities and more, and all organized and conducted at public expense as other factors in public education are conducted and paid for.

At first, as I reviewed the wonderful possibilities, the immense field and how little it had been cultivated, I confess to a feeling of discouragement. Then I thought of the many Music Supervisors throughout this great country of ours, each with its own problems to solve and succeeding in spite of all difficulties; I thought of what already had been accomplished in Buffalo in a comparatively short time under most adverse conditions. I recalled how the sentiment toward instrumental music in the schools had changed among the educators themselves; of the violin classes, (not nearly so many as we should have but increasing in number); of the grammar school orchestras already established through the devotion, clear vision and co-operation of the teachers and principals themselves; of the high school orchestras and the High School Festival Orchestra, the latter organization composed of the most experienced of all the high school players and capable of playing standard music extremely well; I thought of the six double-

basses, the cellos, violas, clarinets, horns and other instruments which the principals had bought with their local school funds, hundreds of dollars worth; I thought of the various teachers in both the grades and the high scools who play orchestral instruments—one the double-bass, one the clarinet, another the viola, another the trombone, and several who play the violin—each doing all he is able to help on the cause of instrumental music in the schools; I thought of the fine pipe organs and the grand pianos the city had included in the equipment of two of our new high schools; and of my ten loyal assistants, four of them recently appointed.

Yes! I thought of all these things and I went out with renewed courage feeling that after all, we had made a substantial beginning on the task of realizing great possibilities.

By giving concerts with the Festival Orchestra, mentioned above, in each of the high schools during the assembly period, a standard has been set to which each local high school orchestra is striving to attain. This orchestra has also given concerts for important meetings held under the auspices of the Buffalo Schoolmaster's Association and for the New York State Teachers' Association. The purpose in each case was to arouse interest and to secure co-operation. I am glad to report that our efforts were successful. If we are to realize on our possibilities we must have the interest and steady co-operation of the principals and teachers.

Our plans for the near future include the formation of a concert band, an organization to include the most experienced players from all the high schools. For this band, with the exception of oboe and bassoon, we have a complete instrumentation including the tympani. Double-basses will play with the tubas and cellos with the baritones. I feel that the work of this band will do for band music what the High School Festival Orchestra is doing for orchestral music in the schools.

We lack oboes and bassoons—not students who would learn to play them but the instruments themselves. Here again there is a wonderful possibility which I look to become a reality in the immediate future; I refer to a substantial sum of money recently included in the music fund for the purchase of such instruments as are most needed to complete the instrumentation of orchestras and bands.

In closing let me remind you, lest we forget, that of all instruments the human voice is, after all, the most wonderful; and while we should make every legitimate effort to realize the possibilities of instrumental music in the public schools, let us not do it at the expense of that which is of greater importance. If I had to choose, I'd have the schools of Buffalo noted for beautiful singing rather than for orchestras and bands. But I propose for the schools of Buffalo just what you propose for the schools of your own cities, namely: beautiful singing *plus* instrumental music.

Discussion.

Mr. C. H. Miller, Lincoln, Nebraska: I would like to ask Mr. Beattie if any of the teachers were found, to any extreme, to be unsuccessful in the handling of their classes? Or if you took any pains to see if those who took charge of the violin classes had themselves had efficient instruction?

Mr. Beattie: We found it difficult, I will say, to start the work under such conditions as we would have liked. We could not find teachers who

were all the product of the same kind of instruction. However, I had reason to believe that all the instructors appointed would be successful, and I think the demonstration proved that I was correct to a great extent. We did get a kind of standardized result by insisting that all teachers use the same instruction book.

Mr. Arthur Abbott, Buffalo, New York: It might not be the right thing for me to ask the next question, but I should like to ask whether or not, in the case of some teachers, the work degenerated into individual instruction, and pupils dropped out?

Mr. Beattie: That was true in one case. The work "degenerated" into individual instruction but the pupils did not drop out.

Mr. Abbott: If the children have had lessons with a private teacher, and have dropped them, do you allow them to enter these classes?

Mr. Beattie: If the lessons were taken several years ago, we would permit such children to enter. We are very careful, however, to see that children who have studied privately recently, do not come into the classes. I want to make it clear that not one of the children on the stage has ever had any instruction save what he has received in our classes. All of the group which has just played, were absolute beginners last October.

Mr. White, Bay City, Michigan: How are the difficulties of tuning overcome?

Mr. Beattie: Just as they are in the case of individual pupils. We try to teach every pupil to tune his own instrument. Of course, in the first place, we try to eliminate all pupils who have poor ears and no aptitude for music.

Mr. White: How much do you pay the teachers?

Mr. Beattie: $2.00 per lesson, which is not enough.

Mr. Ferguson, Piqua, Ohio: I want to ask about the rate of progress. Do not some children make more progress than others? How do you take care of this?

Mr. Beattie: By dividing the children into groups, according to their varying abilities.

Mr. E. M. Hahnel, St. Louis, Mo.: Is this work, this ensemble work credited? Do these pupils get credit in the high school?

Mr. Beattie: Yes, they get credit in the high school work.

Mr. Birge, Indianapolis, Ind.: I would like to know if any of you have had trouble in instrumental instruction with the musician's union?

Mr. Beattie: The union has always been very friendly to me. Mr. Ruckle is a union man, and they permit his teaching without any objections.

Miss Shawe, St. Paul, Minn.: When does the orchestra meet together and practice?

Mr. Beattie: Unfortunately we are not permitted to take children during the school hours. Mr. Ruckle takes one group in the morning, one at noon, and one after school at night, thus working all day long.

Mr. Aiken, Cincinnati, Ohio: Some of the hardest battles I have ever fought, have been with the musician's union. Some twenty years ago they took every child out of our orchestras. Every man who belonged to the labor union, took his child out of the orchestra. I went to the musician's union myself. They are not sufficiently broad. Now, however, they are leaving us entirely alone. Our orchestras are never used outside of the

schools to which they belong. We have to be very careful. We go to hear Mr. Kunwald's orchestra. We get tickets for $2 for the whole season, which makes it about 15c for a concert, thus getting the benefit of his leading and the rehearsal. We link up in that way in the same orchestra in having one leader. Above all, in the matter of the musician's union, we have to be very careful.

Mr. Ferguson: To return to the matter of credits, I find difficulty in finding schools where some eight credits out of thirty-two are allowed for graduation. I have very great difficulty in inducing them to allow that many credits. I would like to know how many credits you are allowing out of a possible thirty-two or sixteen? I am encouraging my pupils by telling them it is better to graduate with thirty-four or thirty-two credits than merely with the required thirty-two, but this is not always a strongly appealing argument.

Mr. Hayden, Keokuk, Iowa: It is possible that some of you who heard Mr. Wood's address are a little discouraged in regard to his statement of the necessity of having teachers who are able to play as well as teach instruments. I know a number of successful teachers who play only the piano, and some who play that only very little. Now I am not saying it is not desirable that the supervisor is able to do this. On the other hand, however, some of our best supervisors themselves cannot play these orchestral instruments and still are getting good results with their orchestras.

Mr. Ferguson: I insist on my question being answered.

Mr. Hayden: The University of Minnesota gives 5 credits for music work.

The Universities of Nebraska, Wisconsin, Minnesota and Iowa also were mentioned by other members as giving credit for high school music work.

Wednesday Afternoon

MUSIC AND MORALITY (A PSYCHOLOGICAL PHASE)

By WILLIAM JOSEPH FINN,

Conductor, Paulist Choristers of Chicago

Father Finn spoke in part as follows:

Temperamental eccentricity has always been an easy target for the javelins of satirists. A hypothetical type of eccentrics—whose arid souls might be found impervious to the influences of music—elicited from Shakespeare the master verse of juridical sarcasm. His incomparable idiom is most persuasive that:

"The man that hath no music in himself
Nor is not moved with concord of sweet sounds,
Is fit for treasons, strategems, and spoils.
The motions of his spirit are dull as night
And his affections dark as Erebus.
Let no such man be trusted."

But why waste such finality of disapproval upon a weird prototype of which there have been so few replicas in the flesh? Universally sensitive to the subtle controls of melody, the whole human family with unconscious spontaneity slips into an incipient state of hypnosis when the Chambard of the arts charms attention by pleasing sounds. The sense of the deeper self (of that illusive astral ego of the psychists) reacts as immediately to the stimulus of music as the intuitions of an infant to the mother's voice.

There are individuals who experience no emotional reaction from many forms of musical composition. But the extraordinary individual who justly might be delivered to the gaoler at the assizes of the honorable William Shakespeare would be marked off from his fellows by even more signal evidences of idiosyncrasy.

Indifference to the appeal of music has never been characteristic of any people, civilized or barbarian. Rather do all the days (and nights) of History discover a universal response to the surreptitious whispers of melody. For music is indeed the Fairy Princess in the Throne Room of the Arts, and never more abjectly has the world paid homage at her dais than in the current century. So great is the demand for the teachers of music that quacks may sell for ready money a poorly disguised charlatanism. * * * Musical organizations of all types flourish generally.

* * *

Perhaps it would be interesting to know if this truckling obeisance to fleeting sounds be merely a fetichism concomitant with other wild caprices of modern selection, playing disastrous havoc with the race's sense of values, or if so extensive a dependence upon music be justified in the advantages accruing to the preventive or perhaps constructive development of communities.

An adequate answer to this question should reveal consideration of the faculties, intellectual or emotional, directly stimulated by music; of the certainty of music's influence upon character; of its contribution to the growth of a higher or a lower grade of appreciations; of its possible kinship with spiritual or sensual appetites.

* * *

Psychology having become an objective of most intellectuals in this day, popular attention is focusing itself upon the subtle relationship of the brain and sense impressions, the intellect and the emotions. The spirit of inquiry into the various functions of the mental faculties, and the laws by which their findings influence the will ,has pervaded the popular magazines, and has provided a stock back-drop for much of what is significant in modern drama. Succinctly, the popular intellectual tendency of the present is to catalogue laws by which things seem to happen, impressions seem to be made, and influences seem to be exerted. Even in the amphittheatre of medicine, the juxta-position of mental impressions and physical symptoms is being studied as an important branch of Therapeutics.

One may reasonably wonder, therefore, at the meagre consideration given the psychological phases of the great art of music. For music is psychological before and after it is physical.

* * *

Music is sense-impressive. But it must be intimately related to a mental faculty. Real musicianship involves an understanding of the psychological processes by which a melody affects the will.

* * *

The chief function of Religion is to make men spiritual. The chief end of education is so to coordinate the forces that float around in the atmosphere of human lives as to make them into agents of growth towards an active appreciation of the realities of life. Can the qualities of music be so co-ordinated? If yes, then music may be a sturdy and commendable avocation. If no, then better leave the manufacture of sweet sounds to those who can create most sweetly when their locks are straying languidly below the par of convention, whose greasy eccentricities dispute jealously for primacy among emasculated traits.

But at least music is a great force. Has it a moral signature?

It is intimately allied with the routine of life. It is a companion in joy, a mourner in sorrow, an accessory to religion, a strong magnet to dollars. It is a great fact of civilization. Is its rank morally, then, significant? or as insignificant as the sounds by which it reveals itself are fugitive? If one may discover a signature of ethics which operates synchronously with and similarly to the key and rhythm signatures, then it is fair to conclude that music by itself may accomplish ethical purposes. Otherwise, one must conclude that unless musicians are themselves purposeful, they are wasting time, money, energy, and dignity, in a purposeless avocation.

To have right to a definite moral rank, music must be observed to be in control of definite combinations of sounds which heard alone, disassociated from text, convey unmistakable ideas of sensuality or spirituality; of despair or confidence; of worldliness or mysticism; of fatalism or faith.

Here is an iconoclastic thesis: *Music has no moral gamut.* It is unmoral, whimsical. It lacks the elemental qualities which would give it a

precise ethical value. * * * The morality of music therefore is accidental. It is determined by the subjective experiences of performer and listener. * * * Music is only a carriage. If it bring dynamite to the nursery it is accessory to a bad purpose. If it bring food to the starving, it is serving a good end. But it is indifferent to its freight. Therefore it is unmoral.

This denial to the popular art of definite moral rank must not be construed to be a comprehensive minimizing of its efficacy. For, as an expression of traits, one is pleasantly compelled to admit, and as a record of tendencies of particular epochs, Music shares equal honor with Literature and Art.

* * *

The disintegration of standard art forms and their reassembling, the capriciousness of ephemeral and dangerous fancies, the restlessness and superficiality characteristic of definite epochs, the hysterical rejuvenations of the Renaissance, these have all recorded themselves in Letters, Art, and Music, with almost unvarying uniformity.

* * *

Certainly there is a homogenity in the three arts. This confines itself to their fitness to record tendencies and reactions of particular periods. But it does not extend to their qualities as instruments of ethical influence. Art and Letters on the one hand, and Music on the other, must of necessity impress men by different systems. One is direct, the other indirect.

* * *

There is, of course, a negligible literature, a purposeless art, an unmusical music.

* * *

Literature and Art present immediate evidence of good or evil. This evidence is apprehended by the intellect at once, compared with an ethical code, and presented as a tagged influence to the will to be applauded and accepted, or to be disapproved and rejected. The first impressions from these are direct. Arrived at the court of the will, they become colored perhaps, or even transformed altogether by impressions which have originated in other sources, notably in the memory, conscience, emotions. No impressions, whether intellectual or sensuous (in the broader meaning of the term) operate alone in the amphitheatre of the human soul. But in spite of the complex processes by which the moral effect of any experience matures, the moral rank of the force by which the dominant impression was conveyed is conditioned similarly viz., upon the directness with which its offering is labelled good or bad before it is presented to the will.

Equivalently, then, Art and Letters have an objective morality. They convey good or bad ideas immediately. Consequently artists and writers may judge by sure criteria the moral value of their efforts. The whole world may know the efficiency of lives devoted to either of these professions. But it is not so with musicians.

Music exercises a sovereign appeal by statutes difficult to discover. *Her purpose is to establish moods.*

* * *

Music has no inherent quality which forces it into relationship with the intellect or will, directly. Only the emotions can translate its vocabu-

lary. Whenever an intellectual impression eventuates, even subconsciously, it is not due to the music heard but rather to the association of ideas provoked by an emotional sensation.

* * *

Music, therefore, has no definite place in the scale of moral forces. Its jurisdiction is over non-cognitive faculties. It is an influence with merely collateral moral possibilities.

There is no law of music structure by which a specific idea or a particular mood can be unvaryingly generated by specific sounds.

Stateliness, dignity, solemnity, or their opposites, may be immediately discerned in music, but it is the rhythm, the tempo, and perhaps, too, the dynamics, rather than the strict progression of musical intervals, that make such judgment possible. A brass band is counted among the assets of patriotism. Given the rhythmic strains of a full-scored march played by bandsmen embroidered with gold, a vigorous juggler tossing a silver-globed baton, flags flying the while, plenty of soldiers keeping step, and a hysterical enthusiasm for the "Star Spangled Banner" will ensue. But place the band in a shell for a routine concert, and the same martial strains may soothe to a bucolic placidity. There is no patriotism in "patriotic" music save by association.

If the moral impetus excited by an emotion be good, then the evoking agency is by circumstance good. If evil, then the force becomes temporarily evil. Music takes on the morality of the impetus which it has occasioned. Its psychology is that of the mood which it establishes in individuals. There is no vernacular in the sayings of music. Nor can a lexicon be found for defining her speech.

* * *

Against this thesis are alleged sometimes the feeling of abandon which frequently coincides with the hearing of cabaret music, and the spiritual exaltation which is experienced while listening to music in churches. But the former must not be charged against the inherent qualities of music, but rather against the atmosphere of cabarets in general, and to the responsibilities of the individuals themselves the latter is due, not to an intrinsic spirituality in the music, but to the surroundings, the predisposition to be excited spiritually, and to the religious motives dominating the performance of the music.

Therefore it must be concluded that great as the potentialities of music may be, there is no definite ethical significance in its essence. It may be an influence of tremendous moral suasion, or it may be without moral appeal. As an asset in our educational schemes, it may accomplish the results claimed for it, or it may be altogether without lasting effect.

The conclusion which I should like to have made plain is that unless a musician has a serious purpose of expressing through the mediumship of music some very definite moral messages, intimations of strength, nobility, religion, his professional exercise of the art is an unforgiveable misuse of time, an unpardonable trespass upon the refined credulities of the people.

Following Father Finn's address the program printed below was presented as additional illustrations of the music work regularly carried on in the schools.

The Department of Music, Grand Rapids Public Schools, presents a

Concert by the Grade School Bands and Orchestras and a Chorus of 1000 Children from the Sixth Grades for the Entertainment of The National Conference of Music Supervisors at the Armory, Wednesday, March 21, at 3:00 P. M.

Program

1. First Prize March............................*Wheeler*
   Pleyel's Hymn.......................Arr. by *Wheeler*
   Light and Airy Schottische..................*Wheeler*
   Beginners' Band, Direction of Leo E. Ruckle

2. Manrico Overture......................*C. W. Bennett*
   Romance .... *Tocaben*
   Combined Grade School Orchestras, Direction of Mr. Ruckle

3. America the Beautiful, Words by....*Katherine Lee Bates*
   Chorus and Orchestra, Direction of Mr. Beattie

4. The Flag is Passing By.................*C. E. Connew*
   Mother Love...............*Harvey Worthington Loomis*
   Welcome Pretty Primrose.................*Ciro Pinsuti*
   Chorus (Unaccompanied), Direction of Florence E. Allen

5. Old Folks at Home.................*Stephen C. Foster*
   Chorus and Audience, Direction of Mr. Beattie

6. The Walrus and the Carpenter { Words by *Lewis Carroll*, Music by *Percy Fletcher* }
   *Chorus and Orchestra, Direction of Mr. Beattie

*The following statement was made.

Mr. Beattie: "Before directing the children in their rendition of the 'Walrus and the Carpenter', I wish to say a work regarding the manner in which this work has been prepared. The children seated on the stage represent fourteen different buildings. All the work rehearsing the children has been done by the teachers in those buildings, except one massed rehearsal, which I conducted. I wish to give the teachers full credit for their work and to thank them for their splendid spirit of co-operation."

FORMAL BANQUET

Shortly after six o'clock Wednesday evening almost four hundred of the supervisors, crowding the spacious banquet hall of the Hotel Pantlind, sat down to a generous meal. There was abundance of singing from the new pamphlet, Fifty-five songs and choruses for Community Singing which C. C. Birchard and Co., Boston, Mass., is publishing for the Conference. Short addresses were made by Mr. Percival Chubb and Father W. J. Finn. After many jolly demonstrations were given by various groups as to why our meeting next year should be held in Boston, Evansville, Oakland, Chicago, Des Moines, or some other city, Mr. Samuel C. Lancaster presented some phases of the claims of the West, especially as it related to the State of Washington. He gave with the aid of a number of marvellously beautiful colored lantern slides, a lecture on the Columbia River Highway. His audience was held in rapt attention by the superb views and his graphic description of the wonders of the scenery of the West.

Fourth Day, March 22

MORNING MEETING

TOPIC: THE EDUCATION OF THE MUSIC SUPERVISOR

President Dykema: At our Supervisors' Meetings there are usually present only people who are particularly interested in our work. We are in danger of forgetting that our subject is only one of many. I am glad therefore, to bring in a representative of those other workers in Education with whom we must necessarily be in constant and intimate touch—the City Superintendent of Schools. Supt. John H. Francis, while at Los Angeles, gave many evidences of his breadth of educational view; we are glad that his present location in Columbus, Ohio made it possible for him to come to us today. He will open the discussion of the topic.

Supt. John H. Francis introduced himself by saying that he had much hesitation in talking to this body of Supervisors on the Education of the Supervisor since it was a well known fact that Supervisors had been busy for many years trying to educate the Superintendents. The following notes give the points made by Supt. Francis, but as no stenographer was present, his exact language is not quoted.

There are three important factors for us to consider in connection with all education . What is Education for? What is Education? And, Who are Educated?

There is always much doubt as to who are really educated. It is certain that some who are well educated think they are not, and many who think they are, certainly are not. There is a false belief that the person who holds a degree is educated, and the world is full of uneducated people hiding behind degrees.

There is a story of an Irishman who applied for a position as janitor in one of the high schools of a large city. When it was discovered that he could neither read nor write, he was rejected because no one could be connected in any capacity with that school, who could neither read nor write, so he went out and started business for himself. He eventually bought the gas plant and the trolley system, and wishing to launch out into larger enterprises, went to the bank for a loan of a hundred thousand dollars. The banker was glad to arrange it, and made out the note for the Irishman to sign. When he acknowledged that he could neither read nor write, the banker said, "You are a very wonderful man to do all you have done without an education. What would you be if you had been able to read and write?" "Be gorra!", said the Irishman, "I know what I should have been. I should have been janitor of 92nd Avenue High School."

It would seem that in these days of tests, measurements and surveys, we might arrive at an agreement as to what education is and what it is for, and there are two quite distinct methods of determining certain facts regarding education. These may be illustrated by applying these tests to discover whether or not a dog is able to swim. The dog might be measured and weighed, the length of the possible stroke of his legs could be taken in-

to account, the fact that his legs might move together in pairs or one at a time, the length of his tail and the angle at which it points could be considered; or,—the dog might be taken by the nape of the neck and dropped into the water.

We agree that music is educational, and that it must be treated as an educational force in order to secure results.

But Educational work has suffered too long from the theory that education is an end in itself, and music is suffering from the same mistaken theory. Music must not be an end, but a means to an end, and that end the development of the child. There must be growth in technical facility, growth in understanding, growth in taste, but growth in life must be the outcome of all effort, or no result worth while has been reached.

Some argue that music should be made obligatory for every student in the High School, but until I am satisfied that music is the best means for developing all the pupils, I should not agree with them.

I am quite willing to concede that music is possibly the most universal means of development, a close second to Art, if it is to be used as a means for stimulation.

A tremendous mistake has been made all the way from the University to the Kindergarten in assuming that we can give a thought to a child. The child has *all* in potentiality, we cannot give him anything. I might be able to stimulate in you something that you already possess, but unless it is already in you, I cannot even do that. If potential music is in every child, then I am in favor of music for every child. But to force music upon those who have no taste for it is a waste, and I object to waste.

A foundation must be laid if good results are to be reached, but music is not foundational. In the past, music was not recognized as belonging to general education, and it has required a long time to gain a place for it in the curriculum. But now that it has gained this recognition, its advocates are using their influence to keep other subjects out, making the same mistake that was made by other teachers, in attempting to keep music out.

Even reading and writing are not fundamentals, but the are essentials. Knives and forks and spoons are not the meal, but they are essential to it. Even here we see tendencies to bad proportion in the fact that as the number of knives and forks and spoons increase, the food value of the meal often decreases. Are music teachers entirely free from the mistaken idea that the increase in number of knives and forks increases the value of the meal? Are they not often more concerned with the implements than with the thing itself?

There are no uniform, universal things for all of us. True education must meet the needs of the individual child.

A teacher called my attention to a young girl with great talent for drawing, and said, "What shall we do with her?" Surely, what shall we do with her? There is no place in the educational system for one who has no taste for mathematics, for science or for languages, but who has a great talent for art. So we give her ten hours of mathematics, ten hours of language, and a little drawing. We do this because if we fail to do it, she cannot enter college, and she would be deprived of a degree, and her parents of the pleasure of seeing her take her diploma; thus spoiling one of the great potentialities of life in trying to lay a foundation.

While I am not yet convinced that music should be obligatory for all, I am in favor of its taking a bigger place. The time is coming when opportunities for study of all musical instruments will be offered at public expense.

I realize that when I make a statement to teachers, I make it to a conservative crowd. Supervisors of music should take care not to be conservative about that which has always been, simply because it is the custom.

Let us get the theory and the purpose of the whole thing. What can you and I do to develop each individual child?

In trying to carry out a system, we forget the end for which the system was organized. It makes me think of the Irishman who was digging a ditch and a passer by asked him, "Why are you digging that ditch?" He answered, "I am digging the ditch to get the money to buy the grub that will give me the strength to dig the ditch tomorrow."

The Supervisor of Music should see the purpose of his work. The Music Supervisor should be inspired with the thought of service to the individual child.

There are no new systems; no matter how original you may think you are, if you look far enough, you will find the same system promulgated by others. A system builded by one if followed slavishly by others, is no good. If the Music Supervisor finds failure in teachers and pupils in the carrying out of her plans, then the plans are not right. Do not sacrifice individuality of teachers or pupils to the system. Suppression of individuality is the worst thing you can accomplish. One who supresses individuality is no music teacher, she loses all by making a success of her system. I do not want a Supervisor who is too sure of the perfection of her plans. Plans must be flexible; let the boy who can not sing, play or dance or do anything with rhythm in it.

Supervisors only are inspirational who can inspire. Keep in touch with the best things and keep growing.

I cannot help feeling indignation when I see a teacher trying to follow the directions of a Supervisor by putting a child through the drudgery of technique. Some teachers can carry on both technique and inspiring music, but too many are holding to the technique alone.

I should prefer that my child had no music rather than that he studied it with me.

The time should come when there will be a special teacher of music in every large building.

Supervisors must see the growing tendency to socialize all subjects. I predict the time when there will not be a High School that will not look after the leisure time of the boys and girls. Social centers will be provided for all the leisure time.

When this time comes, music will be one of the most important means of activity and entertainment. Opportunities for choral and orchestral practice will be available to all. When these forces are at work amongst our high school pupils, 90 per cent of the money spent in taking care of criminals will be saved, and an overwhelming per cent of those who are now morally crippled will become useful and happy citizens.

A Music Supervisor must not be so scholarly and dignified that he cannot appreciate rag time.

At this, an expression from the audience, of mingled approval and disapproval, led Mr. Francis to say, "I expected that," and then, with a laugh he added, "Lead them from where they are to where they ought to be."

President Dykema: The chair does not desire at this time to discuss the many excellent suggestions in the address to which we have just listened. However, I cannot refrain from making some rejoinder to the remarks concerning rag-time and the desirability of the supervisor using it in order to lead children on to higher music. The same sort of argument has been advanced to get supervisors to use the music period for athletic rallies. Earnest high school principals have said "Put your music aside for a time and sing some of these football songs and lead the children in these football yells. It will create a fine spirit and moreover, that is the type of music that is on the level of these children. By doing this they will be more ready to take the kind of music you wish them to have." There are two objections to this point of view: first, the assumption that football yells and ragtime represent the type of material which appeals deeply to high school students; secondly, the assumption that the supervisor should take his music time for this type of work. It is only a small fraction of the whole boy and girl which cares for football yells and ragtime; the better part of their natures and by far the finer part, is appealed to by sane talk and good music, and we are doing them an injustice if we assume that the poorer material is what they want and that they take the better material only under sufferance. If the good is given a proper chance, it will appeal to the adolescent boy and girl. Secondly, even though there is a place for the football yell, it is not a part of the supervisors problem to attend to it. That can quite as well be taken care of by the student yell master. The same way with ragtime. If the students must have it, let them use their own play time for it, but let no supervisor waste her precious minutes in using this material, the very great proportion of which is not only useless but harmful.

I am pleased to introduce as our second speaker Supt. A. S. Barker, of Oakland, California.

Supt. Barker, of Oakland, Calif., in a brief speech said that in the past thirty years, he had attended many teachers' Institute and Conventions, but in none had he found the enthusiasm this gathering showed.

No educational meeting he had attended had proved so valuable to him as a superintendent of schools as this one. He hoped the time would soon come when the Supervisors of Music will hold their convention in conjunction with the National Convention of City Superintendents. It is the superintendents of the country who need the arguments that the members of the conference have been giving.

President Elliott made a special plea for subjects developing skill, and put music first in the list. No subject is more valuable for education: it demands great concentration; its immense cultural value alone justifies its place in a school curriculum; its social value is unequaled.

Mr. Barker stressed the need of training in music as a vocational subject, especially in high schools. The United States spends more for music than for public education—why not give children musically inclined a start toward a thorough musical education as well as toward a technical or classical education? Four years ago, Mr. Barker began work on these lines

in Oakland. Instruction was departmentalized—electives were introduced in the H. S. curriculum, choral courses, history, harmony and instrumentation. These courses have been so popular that of 4000 pupils, over half have elected music. For this work, fourteen teachers are hired, but the expense is no greater than before because fewer teachers are required for other elective studies. The only added cost of music to the city is found in the free lessons in all band and orchestra instruments given by private teachers to children in all schools of the city.

At the close of Mr. Barker's speech, President Dykema called the attention of the conference to the fact that Supt. Greeson of Grand Rapids had said he had received more benefit from this meeting of supervisors of music than from all the superintendent's conventions he had ever attended. Addressing the three superintendents directly he said, "Gentlemen, you have spoken enthusiastically of the value of music and the need of its being given greater attention in the schools. Now the people who to a large extent control the amount of time and effort given to the various subjects,—we want your help in getting the Superintendents in general to care more for music. We believe that one of the best means for bringing that about is to get them to sing themselves. We ask you, therefore, to use your influence to have on future programs of the National Superintendents Conventions periods of Community Singing—singing by all the superintendents. If you will arrange for the time we will supply the leaders and get the results."

Chas. H. Farnsworth, Teachers' College ,New York City: In the opening discussion, Superintendent Francis emphasized, very truly, the necessity of discovering the talent we would educate. This is especially true in respect to the music supervisor. We must catch him before we commence to educate him. To find the person with the requisite qualifications, musical, executive and social, is growing more and more difficult in the rapid development of our schools and the greater demands they are making musically.

We are too much inclined to think of education with reference to what we wish to teach, rather than with reference to the talents we wish to cultivate. The latter would have this advantage, that it would keep us from making the mistake of trying to cultivate people along lines of work for which they have no aptitude.

"He who cannot do, teaches," is a remark that is often quoted and implies that a teacher's equipment, as far as natural talents go, is rather negative than positive. In a sense this is true. If all of us here, interested in teaching music, had the talent and training of the great concert artists, we probably would not be here discussing supervisor's problems. But does this fact imply that there are no positive talents necessary for a sucsussful teacher? Might we not have unusual musical gifts and training, and be very unsuccessful as teachers?

In the few minutes that I have, I would like to suggest what seem to me to be the three fundamental qualifications, and upon the development ces of the real about us; one that, by the possibility of its attainment,

1. **A creative imagination**
2. **An analytical mind**
3. **Social capacity.**

By creative imagination, I mean that ability to construct an ideal that shall not be merely visionary, but that shall be made out of the cricumstances of the real about us; one that, by the possibility of it's attainment, stimulates us always onward. While on the train coming here, I had the pleasure of talking to a man whose son, some dozen years ago, played with the son of Mr. Ford of Detroit. The boys often went on walks and occasionally Mr. Ford accompanied them. The gentleman on the train told me of conversations his son reported, concerning what Mr. Ford planned to do; plans which are only now being realized. Mr. Ford had the creative imagination to see, a dozen years ago, what might be done in the future. Applying this to music, for instance with reference to tone quality, the supervisor must be able to hear in the rough and untrained voices before him, the mellow, rich and brilliant tones that the right training will make possible in the future.

He must be able to imaginatively create this ideal so vividly, that for years it will help him to gradually bring up his work, for without such an ideal it is the easiest thing in the world to accept what we do for what we would do. The human mind has a facile ability for disregarding what it does not like. We easily forget the errand we do not want to do. I remember, years ago in the early days of my piano instruction, playing duets with a young lady who possessed an old-fashioned square piano similar to the one I was using. Sometimes we would play on her piano and sometimes on mine. I often used to wonder how it was that she could play on a piano so badly out of voice and tune as hers, and I know, from remarks that she let fall, that she had somewhat of the same opinion as to my piano. In other words, we were both critical of the other's instrument, rather than of our own. I account for this in this way. In the constant practice on our own pianos, our musical ears adjusted themselves to the noticeable faults of our own pianos, including the peculiar way in which they went out of tune. But as soon as we heard another piano, to the tones of which we were not adjusted, we experienced distress of which we were not conscious when hearing our own instruments, though to a stranger the difference between them would not be worth speaking of.

I have noticed the same thing when visiting schools; in having a supervisor show extreme aggravation at what we were hearing, utterly oblivious to the fact that to me his school was quite as deficient as the one he was criticizing. In other words, we gradually adjust ourselves to the imperfections of our own work and thus lose the capacity for vigorous self-criticism. If, however, we possessed a strong, creative imagination, we would tend to be critical, not only of the work of others, but also of our own work.

For the second aptitude I have suggested the analytical mind. By this, I mean a capacity to sense the causes that lie back of effects; to relate these and discover methods for producing good results. If the creative imagination helps attain the ideal, the analytical mind discovers the rule by which this should be attained. Persons strong in creative imagination but weak in analytical mind are those who are full of enthusiasm for what they do, but fail to discover the proper methods to accomplish them. In fact, such people are often impatient of methods and are con-

stantly shifting from one thing to another, thus never attaining the results that they so vividly imagine.

On the other hand, those who are strong in analytical mind but weak in creative imagination exalt their methods into a system. They see everything in processes; they are the true methodists and get so enamored of the way they are doing, that what they accomplish is of little artistic value.

The third and final aptitude is social capacity. By this, I do not mean skill at small talk at an afternoon tea, but primarily a capacity for a vigorous and accurate use of the mother tongue; the ability to get over to the audience, say of teachers, the musical ideal and the method by which it should be attained so effectively, that the listening teachers shall be convinced and stimulated. Other qualities, of course, are implied under social capacity; that misnamed one called common sense, so necessary in dealing with people, if we wish them to do what we plan.

The caution of the President with reference to time, will allow me only to hint at what the education of these aptitudes should be. The musical imagination is primarily reached through the purely musical side of the supervisor's education—voice, instruments, theoretic and appreciative work, and the opportunity of hearing fine performances of great works.

The analytical mind could best be cultivated by a general education, especially philosophical and psychological, and work in methods, both general and specific, as regards the teaching of music.

The social capacity would demand training, especially in the mother tongue; modern languages, history and literature, and a wide experience in student and social activities.

Looked at from this point of view, the education of the supervisor is not a summer school affair, but a severe discipline as exacting as that for a lawyer or a doctor. It should be based like theirs on a high school preparation, and continued, if possible, through a mixed education both musical and academic. This, unfortunately, neither our conservatories nor colleges are completely offering. The liberalizing of both secondary and college courses of study, by allowing an opportunity for music to be carried on with other studies, is making possible the kind of training we have here sketched out. With such a program we see how false it is to say that "he who cannot do, teaches." We would respectfully invite the gentleman who originated the remark to try the education of the supervisor and see whether he would graduate without doing.

Caroline V. Smith, Winona State Normal School, Winona, Minnesota: If we could have seen Grand Rapids fifty years ago, and a group of supervisors assembled for a Conference, we would no doubt have discovered a very great contrast in the town and in the enrollment of teachers as compared with what we see at the present moment. The title of Dr. Charles Eastman's most interesting book "From the Deep Woods to Civilization" would happily express the changes brought about during the half century just gone by. A vast wilderness has been transformed into beautiful towns, and in one of these is assembled at this hour hundreds of music supervisors.

If we stop long enough to think that the mother of American music was New England psalmody, a stern and narrow minded parent, with a decided distrust of music—and then again of "Old Hundreth" as the highest

type of Puritan musical effort, we ought not to feel discouraged over a twentieth century outlook upon musical education.

Public school music is only a little more than three quarters of a century old. Lowell Mason, who established the first system of public school music, died in the year 1872, something like forty five years ago. The pioneers in music-teaching well remember the texts issued by Mr. Mason, and the precepts of his pupils.

A number of cities which claim well organized school music courses today were not upon the map of this country at the time Lowell Mason began his work in the year 1836.

Minneapolis, with its world famous symphony orchestra was an endless western prairie only sixty years ago, the music of that time consisting of the song and dance of the Indian, swayed often by the sound of the wind as it swept across a great trackless space.

Minneapolis which is now a well organized city, has a most efficient system of public school music, under the direction of Mr. T. P. Giddings.

Today this country is spending annually $220,000,000 upon the training of music teachers in studio, conservatory, and schools. Our country is rapidly becoming one of the leading centers in the musical world, our opera seasons, symphony orchestras and choral societies comparing favorably with those of European capitals. I am willing to say that a large share of this remarkable growth in music is due to the music supervisor, and our system of public school music.

We have a great leader in musical education in Dr. Thomas Tapper, whose book upon "The Music Supervisor" is an inspiration to all engaged actively in this work.

Mr. John C. Freund is doing noble missionary work in devoting many pages of "Musical America" to college and school. His work stands alone in Americanizing music.

We can claim our own Eleanor Smith, Jessie L. Gaynor, Alys Bentley, Anice Terhune, Florence Barbour, and others who have created songs for childhood, which are superior to those of any other country. Our publishers put forth every effort to perfect music texts, which stand unrivalled in quality of words and music. We have our own Mr. Dykema who will be known in the musical history of this country as the father of Community Music.

I believe that a more complete organization of our public school system in music would some day lead to a more uniform result. England has a government inspector of music whose efforts are having a far-reaching effect in the school room.

We need a United States Commissioner in School Music, and if each state would appoint a superintendent in music who again would be assisted by a representative, appointed from each congressional district, a more definite und uniform aim would be possible in the education of the supervisor, and in making the course of study.

At present, the supervisor is the result of studio, conservatory and institutional training, and there is a diversity of opinion as to courses, and purpose of a school music system.

A too common difficulty in the department of supervision consists in specializing rather early. Enthusiastic parents, and friends of a musically

gifted girl are sometimes led to think she is wasting time in attending a public school, and so hurry her off to some school of music, with the result that she graduates at an immature age and, having acquired only a one-sided education, she must approach the serious problems of a public school with rather a narrow viewpoint. She is at once confronted with her early deficiencies, and in consequence she fails to grasp some of the most simple things belonging to skillful teaching.

Music itself is not a one-sided subject, but on the contrary, it is a most comprehensive Art.

A specialist in any other subject would not rest satisfied with training received in only a single subject. Musical education should be enriched through ideas gained in other courses; scholarship is imperative in any department of supervision. Academic training gives power in many directions; it lays the foundation of a liberal education so important in any field of special work.

The musical training of the prospective music supervisor should begin early in life, and be continued throughout a public school course. To attempt a two years' course in music upon graduation from a High School, must necessarily prove unsatisfactory, unless voice and piano have received a reasonable amount of time and attention during a common school course.

A fine music foundation is possible during the process of a graded school course, the ambitious student always finding time for extra subjects and duties. The encouragement of talent in our High Schools is commendable, and this is being expressed in a positive way in some localities, by offering credit for special voice and piano training. This greatly stimulates the ambition of the future music supervisor.

Musicianship should be the corner-stone of a course in music supervision, but musicianship alone does not imply skill in teaching. Professional training, and the teaching instinct are quite as necessary in the daily work of the supervisor as in the case of the grade teacher. A child does not learn to sing by accident. The common branches include *music*, and the same principles of teaching underlie each one of the subjects belonging to a common school course.

We are told that the professional training of the grade teacher, under state authority, had its beginning in the year 1839, the first seminary for teachers being established under the direction of Horace Mann. This is a significant fact in the history of public school music, for about the same time Lowell Mason laid the foundation of our modern method in teaching school music.

It may be of interest to know that in Normal School circles, a course in music is being offered. May I present a modest two years' course which is being offered in the Winona State Normal School, because I happen to be more familiar with this institution than with any other.

We are trying to meet the demands of only the small town, and rural consolidated school system. We are not attempting to compare our course with one given in a well equipped school of music, or a special school for music supervisors.

Our special curriculum in music includes twenty-four credits, twelve of which are allowed for common school subjects and professional training and twelve given for music training.

The full normal school course of training to teach is the basis of our special course. In most cases students continue their studio work in voice and piano while in attendance at our school, excellent instruction being given by private teachers in each branch of music.

Our school provides for a term of one hundred and twenty lessons in harmony, sixty lessons in musical history, sixty lessons in methods of music and material, a course in library reading and themes—also in public school music administration.

A group of about one hundred students, known as the MacDowell Club is placed in charge of a candidate for a diploma in music supervision in order that she may gain experience in conducting High School music. This work begins with folk songs, part songs, and sometimes concludes with a simple cantata.

In order to assist further the future music supervisor, we have arranged this year a series of special programs which may be performed in almost any town or village, and serve as a course in musical appreciation.

The year opened with a community song evening, and as a result of this endeavor, a member of the supervision class who is obtaining her practice teaching experience in a three room village school near Winona also organized a community song evening not long ago. This was attended by one hundred and fifty farmers and their wives, and an additional group of thirty persons were unable to gain admittance because of the crowded condition of the school room. A repetition of the event was immediately demanded.

The second number of our series was a "Lohengrin" evening. The story of the drama was beautifully told by the head of the reading department, Miss Mary R. Slifer, who used the Oliver Huckel edition of the lines. The musical illustrations were given by the school choruses, and soloist. These same numbers are possible through the use of victrola records.

At Christmas time we gave a Yule-tide festival, which included the singing of many old carols.

February brought a "Song and Light Festival' at which was presented the 'Tannhauser March,' 'The Heavens are Telling,' 'Hallelujah Chorus,' and other standard choruses and community songs. Arthur Farwell's 'March, March' aroused much enthusiasm at this festival.

This first day of May promises a brief Spring Festival without symphony orchestra accompaniment, all of the musical organizations of the school uniting in the event. The St. Cecelia Society, a chorus consisting of two hundred fifty women's voices will present the Peer Gynt Suite I, in vocal and instrumental form at our festival.

Emphasis is being placed upon our programs because music study and appreciation are fundamental in the life work of a supervisor. A fine musical sense is developed largely through a study of the best musical literature.

We are trying to make as complete as is possible the academic, musiccal, and professional training during a brief two years' course in supervision. Our plan makes possible a combination of grade work, and supervi-

sion. A small town cannot always find ways and means of employing a corps of supervisors, but upon combining grade work and supervision, excellent results are obtainable sometimes.

At least, our plan is making *music extension* possible, and is offering a music course in towns which otherwise might remain without the subject.

The census office tells us there are sixty million inhabitants in the rural sections of this country, as compared with forty million who are living in cities.

The village and small town,—and their number is legion, present the greatest problem in the matter of music supervision, for well directed effort is quite as important in the rural community as in the large city.

At best, we would not expect the village to compare with the metropolis in any form of supervision. The glory and beauty of the great symphony is within easy reach of the more fortunate, while there are those of us who must rest satisfied with the music of a single violin.

But it matters not what may be our place in the field of supervision, we are all teaching a subject which is the most positive means of Americanizing a great cosmopolitan nation. However humble may be our lot, we each inspire,

"The song that all way-faring men
Shall hear until they die,
That haunts their dreams, and brings again
Under the open sky,
Across the pent, unhappy hours,
Across the clanging towns
The gleam of little wayside flowers
The white tracks of the downs.
The feel of wind upon the face
The fragrance of the pine,
The draughts of keen exultant space
That thrill the blood like wine,
Blue mystic distance, fold on fold,
Luring from far away—
The song Ulysses heard of old,
And the one of yesterday."

We must think of music, not as an accomplishment, but as an inner resource of life, and as a means of cheerful, and unselfish service. I believe the music supervisor is in large measure living up to this ideal of unselfish public service, and some day, in truth, will be realized the words of the poet,

"I see America go, singing to her destiny."

(Note: Mr. Cogswell was detained by illness but sent the following contribution.)

Hamlin E. Cogswell, Washington, D. C.: Today it seems that a Supervisor of Music must be educated in the superlative degree before he aspires to that profession. He must have the book knowledge of an A.M. Ph.D. and L.L.D., the judgment of a Justice of the Supreme Court, the character of an Abraham Lincoln, combined with that martyr's patience and love for humanity, the diplomacy and ingratiating ways of a Bern-

storff in Washington, the personality of a Roosevelt (in restraint) and personality is the gift of the gods, you know.

He must possess the manners of a Lord Chesterfield, and the hang-on-i-tive-ness of a U. S. Grant and many other essentials of leadership. His social instincts must be at the top-notch, his efficiency plus, and his ideals in the stars. He must have creative powers and energy. He must have unflagging enthusiasm and radiate perfect health. He must keep abreast of the times, he must expect a life of sacrifices in one way or another and consider *slightly* the financial returns. When his torch burns out, he must get along the best he can.

He must be educated for social service, and cultivate altruism. He must be versed in all phases of music, be a born teacher and leader, a born organizer, a born mixer, know the secrets of team-work and professional ethics, and I have found that Environment is a wonderful educational factor.

The supervisor may be adequately educated, and possess all the requirements I have mentioned, then be forced to meet problems and obstacles that are seemingly insurmountable. I do not claim this perfect equipment but the problems and obstacles *are* mine in my present administration. I will quote Dr. Schaeffer's allusion to a cartoon in which a mother is pictured as being laid up with illness, and her child near her is saying "Oh dear, *dear*, between the cook and the Kaiser, mother is completely distracted". My position is quite unlike the Supervisor in other cities and towns. The cartoon legend translated into my vocabulary is, between war conditions, Congress, and lack of funds for supplies, I am hindered in many things I could put thru with the educational equipment that is mine and the light of experience.

A very little of the money that is appropriated for preparedness for war, and for athletics, would help materially in efforts for civic betterment and the common good musically.

If discontent with conditions is a sign of progress and we often hear that such is the case, then divine discontent is mine and what is true of my lot is undoubtedly true of other supervisors, except that they do not have to depend upon an act of Congress with "a little group of wilful men" and great international problems occupying their minds and souls hindering a move of any kind, to say nothing of monetary considerations. Now all this means that in my work I must get into the trenches with the privates and all the time battle with the fetich of "precedent". Here again, if my engine will not move without rails, then I must add to my equipment, an inventive faculty.

I am consuming too much of my "ten minutes" singing on the personal note, yet I can not stop until I have voiced the opinion, that in my estimation, an ideal supervisor can not be educated at one, two, three or four terms of a summer school, neither do I believe that any institution can turn one out in a year or two. He must add to his acquired knowledge, *actual experience*.

The School Music World is full of unlit and faintly burning candles but I believe in time to come they will flame brightly and I see in the future (after *my torch* is extinguished, it will be) music in the curriculum of the schools as one of the most important subjects if not *the* most important,

and Boards of Education employing only the fully trained and educated superintendents and teachers.

The music supervisor is out in the open road today, and strides along its highway fearlessly. No "highbrow" can make him afraid. He is gaining in wisdom and efficiency, and if his heart is right, he is not after superficial popularity and personal gain, which is only transitory.

Best of all, Fellow Workers and Enthusiasts, public sentiment is being aroused, and that you know is irresistible. The music clubs, women's clubs and Parent-Teacher Associations are asking for talks, lectures and illustrations on the subject of public school music and if you have been questioned as persistently as I have, you will see their interest is growing stronger day by day, and these are some of the factors that make our profession worth while to us. They oil the machinery and lighten the drudgery.

SOME superintendents and school boards are awake to its importance and we have a Commissioner of Education who is a live wire musically and otherwise.

We no longer hear so frequently the expression, "Oh, he's only a supervisor" made with arched eyebrows, and significant shrug of the shoulder, implying a great lack of musical knowledge and denied a place in the inner shrine.

The question of salary no doubt enters into the consciousness of many who would educate themselves for the profession. Today an acre of ground planted with potatoes will yield a better income and is attended with less harassing conditions. A colored brick-layer with his white chauffeur drives by my home in stately magnificence in his super-six Hudson limousine, while a supervisor I know runs for the street car (when there is no strike on) and "hikes" when there is.

Notwithstanding inadequate salaries there will always be looming up on the musical horizon these humble Apostles of Light, some of them powerful, other mere reflections, according to their gifts and tendencies. The following weak translation from the German sums up the situation:

The world is but a huge orchestra
And we therein must players be,
And she who stirs our human feelings
Is our sweet sister, Harmony.
The great ones standing high above us
Shall the Conductor's part fulfill,
While we poor devils, scrape and fiddle
As best we can, some well, some ill.
And many a one doth vainly fiddle,
Nor clear nor tunefully plays he,
And therefore must for life, content,
A humble bellows-blower be.

*

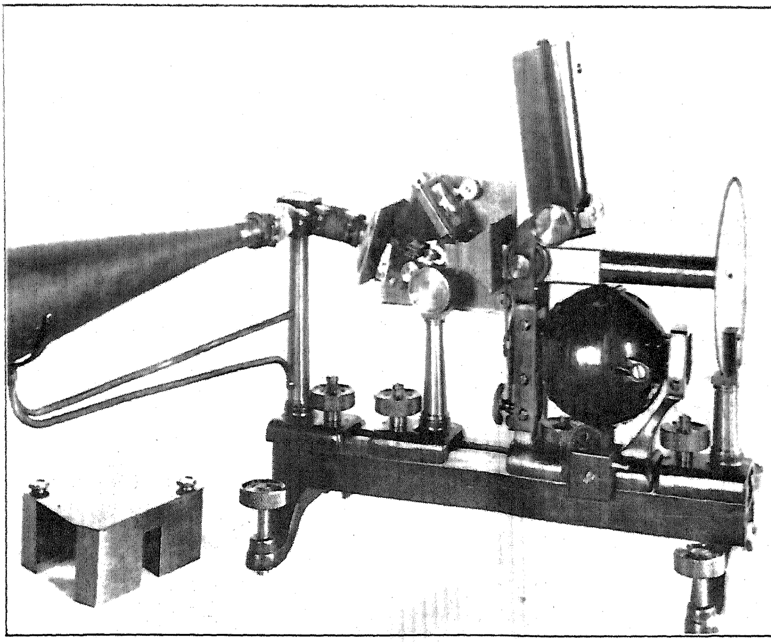


FIG. I—The Phonodeik for making waves of sound visible to a large audience.

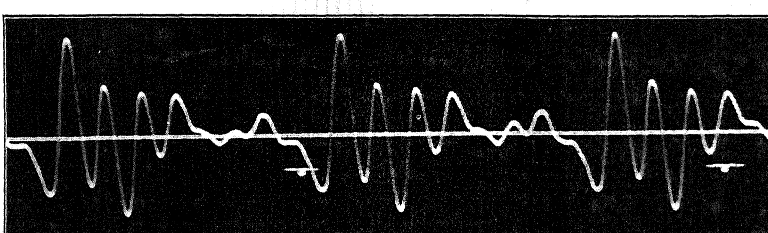


FIG. II—Photograph of the voice intoning the vowel *a* in father upon the note E-b below middle C.

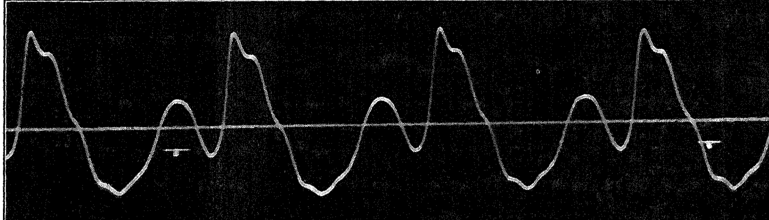


FIG. III—Photograph of the tone of an organ pipe; stop, "Reedless Oboe"; tone, middle C.

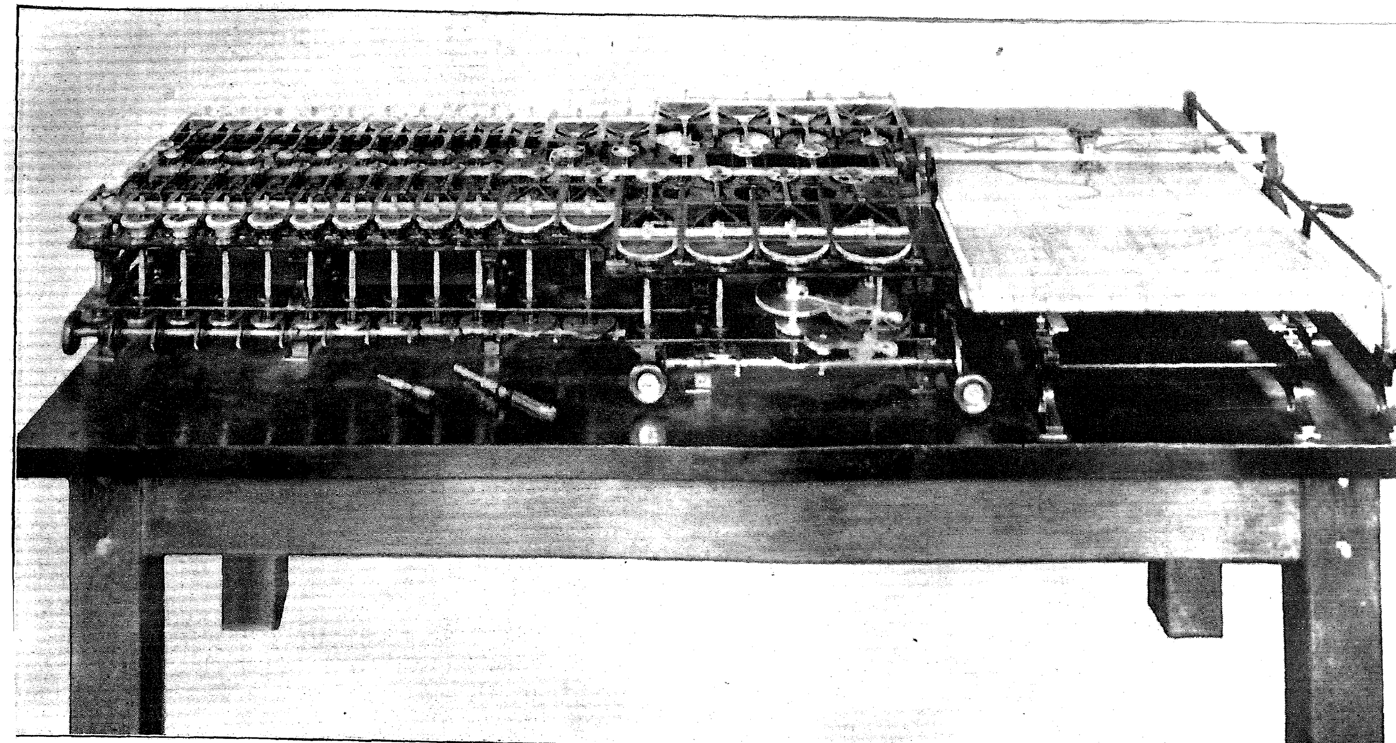


FIG. A—Harmonic Synthesizer for drawing wave-forms corresponding to thirty-two partial tones.

PHOTOGRAPHING AND ANALYZING MUSICAL SOUNDS (WITH EXPERIMENTS)

By DAYTON C. MILLER, D. SC.

Professor of Physics, Case School of Applied Science, Cleveland.

SOUND may be defined as the sensation resulting from the action of an external stimulus on the sensitive nerve apparatus of the ear; it is a species of reaction to this external stimulus, excitable only through the ear, and distinct from any other sensation.

Atmospheric vibration is the normal and usual means of excitement for the ear; this vibration originates in a source called the sounding body which investigation shows is itself always in vibration.

The *source* may be constructed especially to produce sound; in a stringed instrument the string is plucked or bowed and its vibration is transferred to the sound-board and this in turn impresses the motion upon a larger mass of air; in the flute and other wind instruments the air is set in vibration directly by the breath. The vibration often originates in bodies not designed for producing sounds, as is illustrated by the squeak and rumble of machinery.

The physicist uses the word *sound* to designate the vibrations of the sounding body itself; or those which are set up by the sounding body in the air or other medium and which are capable of directly affecting the ear even though there is no ear to hear.

The vibrations of a source of sound produce in the surrounding air displacements, velocities, and accelerations, changes of density, pressure, and temperature, and other physical effects. Because of the elasticity of the air, these changes in density and other phenomena occur periodically and are propagated outwards from the source in radial directions with a velocity of about 1130 feet per second. These disturbances of all kinds as they exist in the air around a sounding body constitute *sound waves* and are the especial object of our present study. Such waves may be transmitted by all kinds of elastic matter, whether solid, liquid or gaseous.

Sounds are fully described by means of these characteristics, pitch, intensity, and tone-quality.

The *pitch* of a sound is that tone characteristic of being acute or grave which determines its position in the musical scale; an acute sound is of high pitch, a grave sound is of low pitch. Experiment proves that pitch depends upon a very simple condition, that of mere *frequency* of vibration; the pitch of a sound is the number of complete vibrations per second.

The *loudness* of a sound is a comparative statement of the strength of the sensation received through the ear. In a first study of the physical characteristics of sounds, we are compelled to consider the intensity not as the loudness perceived by the ear, but as determined by what the physicist calls the energy of the vibration.

The *energy* of a simple vibratory motion varies as the square of the amplitude, the frequency remaining constant; it varies as the square of the frequency, the amplitude remaining constant; or when both amplitude and frequency vary, the intensity varies as the square of the product of amplitude and frequency.

The loudness of what we hear depends not only upon the characteristics of the source and the ear but also very largely upon the peculiarities of the surroundings, that is, upon the auditorium and its contents. Among the features of an auditorium which must be considered are its size and shape, the materials of which it is constructed, its furnishings including the audience, and the position of the source.

The opinion is widespread and deep seated that the acoustic properties of an auditorium cannot be foretold and that a satisfactory auditorium is the result of luck or of a shrewd guess. While formerly this was true, at the present time it is not true. During the past few years, Professor Wallace C. Sabine of Harvard University has devoted himself to elaborate and difficult researches which have developed a thoroughly scientific solution of the problem of the acoustic properties of auditoriums. This solution includes the effects due to both reverberation and echo; it is possible to predict the acoustic properties from plans and specifications; it is possible to prepare specifications which will give any desired acoustic result; it is possible to point out the particular defective features of a proposed construction and to specify the necessary remedy. The nature and amount of acoustic defect in auditoriums already constructed can be determined and these defects can be remedied with more or less difficulty. This is particularly true with regard to reverberation.

While Professor Sabine's methods are thoroughly scientific, yet they are of remarkable practical utility to the architect and engineer; these methods have been described in various architectural and scientific journals.

No auditorium, large or small, and no music room, public or private, should be constructed which is not designed in accordance with these principles. It is almost universal to consult the structural engineer, the heating and ventilating engineer, the sanitary engineer, the illuminating engineer, and the decorative artist. It is certainly true that in an auditorium designed for speaking or music the acoustical properties are of much greater importance than the illumination, and I hope the time is close at hand when architects and builders will always consult the acoustical engineer, in addition to the other specialists. Such engineers are now professionally available.

The utilitarian application of a pure science is nowhere better illustrated than in the acoustical design of an auditorium. For, of what avail is a perfected musical instrument controlled by a master, or a grand symphony rendered by an orchestra of a hundred artists, or of what effect is an oration of perfect composition, pronounced with faultless elocution, if the auditors are placed in surroundings which distort and confuse the sound waves, so that intelligent perception is impossible?

The third property of tone is much the most complicated; it is that characteristic of sounds produced by some particular instrument or voice, by which they are distinguished from sounds of the same loudness and pitch, produced by other instruments or voices; this characteristic may be called *tone-quality* or tone color.

Noise and tone are merely terms of contrast; in extreme cases clearly distinct, but in other instances blending; the difference between noise and tone is one of degree. A simple tone is absolutely simple mechanically; a

musical tone is more or less complex, but the relations of the component tones and of one musical sound to another, are appreciated by the ear; noise is a sound of too short duration or too complex in structure to be analyzed or understood by the ear.

The ear, often because of lack of training, or because of the absence of suitable standards for comparison, or perhaps on account of fatigue, fails to appreciate the relations of sounds, and relaxing the attention the sounds are classed as noises.

The study of noises is essential to the understanding of the qualities of musical instruments and especially of speech. Words are merely multiple tones of great complexity, blended and flowing, mixed with essential noises.

Tones are sounds having such continuity and definiteness that their characteristics may be appreciated by the ear, thus rendering them useful for musical purposes.

There is an almost infinite variety of tone quality; not only do different instruments have characteristic qualities, but individual instruments of the same family show delicate shades of tone quality; and even notes of the same pitch can be sounded on a single instrument with qualitative variations; the bowed instruments of the violin family possess this property in a marked degree.

No musical instrument equals the human voice in the ability to produce sounds of varied qualities; the different vowels are tones, each of a distinct musical quality. The investigation of tone quality therefore naturally leads to a study of vocal as well as instrumental sounds!

The *law of tone quality*, first definitely stated in 1843 by Professor Ohm of Munich is as follows: *all musical tones are periodic;* the human ear perceives pendular vibrations only as simple tones; all varieties of tone-quality are due to particular combinations of a larger or smaller number of simple tones; every motion of the air which corresponds to a complex musical tone or to a composite mass of musical tones is capable of being analyzed into a sum of simple pendular vibrations, and to each such simple vibration corresponds a simple tone which the ear may hear.

From this principle it follows that nearly all of the sounds which we study are composite. The separate component tones are called *partial tones*, or simply partials; that partial having the lowest frequency is the *fundamental,* while the others are *overtones.*

If the overtones have frequencies which are exact multiples of the frequency of the fundamental, they are often called *harmonics*, otherwise they may be designated as inharmonic partials.

Investigation shows that the sound of a *tuning fork* properly mounted on a resonance box gives to the air a *single simple motion,* which being propagated outwards, develops a wave such as is represented by the simple harmonic curve.

If a fork an octave higher is sounded it sends out twice as many vibrations per second, generating a wave of half the wavelength.

If both forks are sounded at the same time, both motions must simultaneously exist in the air. Since the same particles of air transmit both sounds, the motion of a single particle at any instant must be the algebraic sum of the simultaneous motions due to each fork separately.

This argument may be extended indefinitely to include any number of tones, of any selected frequencies, amplitudes, and phases. There are, therefore, peculiarities in the motion of a single particle of air which differ for a single tone, and for a combination of tones; and, what may be called the shape of a sound wave, must be a complete record of the tone quality of the sound.

An adequate investigation of the tone-quality of a sound, therefore, makes it necessary to have visible records of the sounds from various sources, which can be quantitatively examined and preserved for comparative study. The principal methods heretofore employed for making such records are the phonoautograph of Koenig, the phonograph invented by Edison, the telephone of Bell, in connection with the oscillograph, and the Manometric flame devised by Koenig and developed by Nichols and Merritt. None of these methods being of sufficient delicacy, the writer undertook to devise a still more sensitive apparatus which resulted in the production of the Phonodeik, which has been used since 1908. The methods of using the phonodeik and the results obtained with it will be briefly explained.

The *phonodeik* consists essentially of a diaphragm of thin glass mounted on the small end of a resonating horn. Close to the diaphragm is a minute steel spindle, mounted in jeweled bearings; a mirror about one millimeter square is attached to the upper portion of the spindle, and the lower part is made in the form of a pulley; a bundle of silk fibers, attached to the center of the diaphragm is wrapped once around the pulley and is fastened to a delicate spring. Light from a pin-hole is focused by a lens, and is reflected by the small mirror to a moving photographic film in a special camera. If the diaphram vibrates in response to a sound wave, the spot of light will trace the record of the sound on the film.

In the instrument used for photographing sound, the motion of the diaphragm for sounds of moderate loudness is about 1-1000 inch; which, being magnified about 2500 times by the mirror and light ray, produces a record two and a half inches wide. For loud sounds the record may be five inches wide. The film moves with a speed of from one to fifty feet per second, according to the purpose for which the record is desired. For general display, a speed of about five feet per second is convenient, while a speed of forty feet per second makes records suitable for analysis.

Besides the record of the wave, there is placed on the film simultaneously, a zero line giving the axis of the curve, and also time signals, 1-100 second apart, enabling the exact determination of pitch from single measurement of the film.

The camera is arranged with several shutters for hand, foot, and automatic electric release, and for any desired time of exposure.

Thousands of photographs have been made of sound waves from various sources, vocal and instrumental; these waves have been analyzed and the results have been tabulated. While inspection and simple measurement will often give some information concerning these curves, in general they are too complicated for interpretation in their original forms. The curves representing the sounds of music and of speech are properly analyzed for comparative investigation by the harmonic method based upon the important mathematical principle known as Fourier's Theorem.

The numerical method of applying Fourier's theorem to determine the

components of a sound is very long and difficult, and various mechanical devices, known as *harmonic analyzers*, have been made to assist in this work. The analyzer devised by Professor Henrici, of London, the essential part of which is a rolling-sphere integrator, is, perhaps, the most convenient and precise yet made.

The combination of Ohm's Law and Fourier's Theorem leads to the following conclusion: If a series of simple tones be selected which will produce in the air each separate simple wave of the analysis, then all of these tones sounding simultaneously will reproduce in the air the original complex wave, and the blended tones of the entire series will reproduce the original sound as to its tone-quality and other characteristics. Therefore, each component curve of the Fourier analysis represents a component tone, or *partial tone*, of the sound which was photographed.

The converse of the analytical process just described, that is a recombination of several simple curves to find their resultant, is often required. Such harmonic synthesis, like analysis, can be accomplished by calculation, and much more conveniently by means of a machine. A *harmonic synthesizer*, for thirty two elements, has been especially designed and constructed in the laboratories of the Case School of Applied Science.

For purposes of public demonstration, a phonodeik of special construction has been made, which will clearly exhibit the principal features of "living" sound waves. The sound from a voice or instrument is produced in front of the horn; the movements of the diaphragm with its vibrating mirror produce a vertical line of light which, falling upon a motor-driven revolving mirror, is thrown to the screen in the form of a long wave; the movements of the diaphram are magnified 40,000 times, producing a wave which may be ten feet wide and forty feet long. These waves exhibit in a striking manner, the characteristics of sounds from various sources, as seen upon the screen the sound waves are constantly in motion, changing shape and size with the slightest alteration in frequency, loudness, or quality of the source.

(This address was accompanied by illustrative diagrams, photographs of sound waves, and by the projection upon the screen of the actual sounds from voices and instruments by means of the phonodeik. Many of these illustrations, as well as more detailed accounts of the methods and instruments here briefly mentioned, have been given in a book by the author, "The Science of Musical Sounds.")

The analytical investigation of sounds by the methods described has been in progress, under the writer's direction for the last eight years, and it is to be continued indefinitely with all the facilities at his disposal. The great extent of the field and the great amount of detailed analysis and comparison required before conclusions can be formulated render progress apparently slow; yet many results of interest and value have already been attained, some of which have been described elsewhere. Some of the subjects being investigated are: the characteristics of tones from different musical instruments, the nature of vowel tones and other sounds of speech, the nature of noises and their prevention. The method may aid in teaching vocal music and in elocution, and it provides a very convenient test for exact tuning. The ideal musical tone for any voice or instrument

having been selected by the artist, it can be accurately defined and reproduced by the aid of analysis.

The analytical study of sound in general will be of benefit to the art of music. While that which converts sound into a grand symphony and exalts it above the experiments of the laboratory is something free and unconstrained and which, therefore cannot be expressed by a formula, yet the mathematical and physical studies which we have described prepare the "infinitely rich, plastic material" out of which music is made, and they provide the methods and instruments by which music can be analytically investigated. A musician must above all be an artist, and he must be skilled in the technic of music; if, in addition to this, he also has complete knowledge of the nature of the materials and instruments with which he works, he will certainly be a greater master of his art. And the musician who listens will derive greater enjoyment if to the pleasure of sensation is added the intellectual satisfaction of an understanding of the physical nature of sound and sound-producing instruments.

BUSINESS MEETING, THURSDAY, 11:00 A. M.

PRESIDENT PETER W. DYKEMA, Presiding.

The nominating committee, consisting of Mr. Will Earhart, Miss Eleanor Smith, Miss Jeanie Craig, Miss Lillian McCracken, Mr. W. O. Miessner, Mr. E. B. Birge, and Mr. F. A. Beach reported the following nominations for the officers of the Conference for the coming year:

President, Mr. Charles H. Miller, Lincoln, Nebraska.

1st. Vice President, Mr. Osbourne McConathy, Evanston, Illinois.

2nd Vice President and Editor of Official Journal, Mr. P. W. Dykema, Madison, Wis.

Secretary, Miss Ella M. Brownell, St. Johnsbury, Vt.

Treasurer, Mr. James E. McIlroy, McKeesport, Pa.

Sergeant-at-Arms, Mr. T. P. Giddings, Minneapolis, Minn.

New member on the Board of Directors, Mr. J. W. Beattie, Grand Rapids, Mich.

Since the addition of the above new officers is not sanctioned by the present Constitution which still remains in force, it was necessary to omit in the ratification of the above recommendations, the officers of second Vice President and Sergeant-at-arms. However, in order to keep Mr. Dykema in active touch with the management of the Association, it was later voted that as chairman of the publicity committee, he should be considered a member of the executive committee. (see report of Friday's meeting.)

Mr. McConathy presented the report from the Committee on Necrology as follows:

Professor John E. Bailey for 44 years supervisor of music in the public schools of Nashville, Tennessee, died March 13th, 1917, at the age of 86 years. He was the oldest supervisor of music in active service in the country, being a month or two older than Mr. Henry M. Butler of St. Louis, Mo. He taught in eight rooms the day before his death and had started for

school the morning of his death when he was taken ill. He went to the home of a son, lay down to rest, and quietly fell asleep. With him passed away one of the pioneers in public school music.

We miss from our Conference this 1917, one who has for years given of her very life to the community and state in which she lived, and one who has also been an active and enthusiastic promoter of this National Conference. Miss Elizabeth Wellemeyer of Marshalltown, Iowa, passed away Feb. 8, but the message of song to which she gave such beautiful expression sings on and will sing on in the hearts of the boys and girls and in the lives of those in the community of which she was such an integral part.

Mr. A. J. Gantvoort moved that the report of the Committee on Necrology be accepted and adopted with instruction that the committee amplify the data submitted, and add to the report short biographical data regarding other members of the Conference, who have passed away since the organization of this body. Motion seconded and passed.

The report of the Committee on Credits for Outside Music Study in the High Schools was then called for. Mr. McConathy reported that a broad plan for accredited music study had been presented at the Superintendents' meeting, by this same committee, Mr. Birge, Mr. Gehrkens, and himself, and that this report was to be published in full in a Bulletin sent out by the U. S. Bureau of Education and in the annual report of the National Educational Association.

Miss Elsie M. Shawe of St. Paul, chairman of the committee on the Revision of the Constitution and By-Laws made the report of the work done by this Committee, reading each revised article as it stood in the old Constitution and as revised. The complete report is printed on pages 3, 4 and 5).

At the close of the reading the President asked how this report should be acted upon. Then followed a lively discussion in which the following members took part: Mr. Dann of Cornell University, Ithaca, N. Y., Mr. Mason of Columbus, Indiana; Mr. McConathy of Evanston, Ill., Mrs. Frances E. Clark of Camden, N. J., Miss Eunice Ensor, of Detroit, Mich., Mr. Gantvoort of Cincinnati, Ohio, Mr. Hayden of Keokuk, Iowa, Mr. Dykema, and Miss Shawe.

The question that arose was as to whether the Constitution and By-Laws as revised could be accepted and adopted at this meeting or whether they must be presented merely, to be adopted one year hence. Mr. Dykema expressed the opinion that the revision could be adopted at this meeting. Miss Shawe thought this was unconstitutional and that the new By-Laws and revised Constitution must wait one year before being adopted. Mr. Dykema suggested that the report be submitted to the officers and Board of Advisors. Mr. Mason suggested that the Committee be continued and the whole matter be referred to officers and Board of Directors. Mr. Dykema said that the Constitution might be set aside if the whole Conference wished to do so. Mr. McConathy suggested that this body is not the entire membership of the Music Supervisors' Conference of the United States and therefore we have not the power to set aside the Constitution, that by doing such a thing we might establish a precedent that would work great harm. He took, for example, a case in which a meeting of the Con-

ference held in the extreme East or West, and therefore attended mainly by Supervisors from one section, might set aside the Constitution and enact some measure quite unfavorable to supervisors of the other section. The action taken last year regarding the dues, was referred to, and Mrs. Frances E. Clark explained the difference between this occasion and the matter of dues acted upon last year. Mr. Gantvoort asked whether the committee on Revision, was given power to revise for adoption this year. Mr. Dykema read from the book of proceedings of the 1916 Conference. On page 108 it is reported that the committee was continued with instruction to report further in 1917. Miss Shawe thought this made the matter clear that the Committee was appointed to revise the Constitution and By-Laws, but that as this was the first presentation of their work to the Conference, no decisive action could be taken until next year, thus giving the Conference time to meditate.

Mr. Dykema: "May we meditate for a year?" The audience voted Yes! The President thanked the Committee for the work done on the Constitution.

The next piece of business was the consideration of the place of meeting for 1918. Mr. F. W. Archibald of Waltham, Mass., read the invitations from Boston.

Mr. W. A. White extended the invitation for the Conference to meet in Des Moines, Iowa.

Miss Ada Bicking gave an invitation for the Conference to come to Evansville, Indiana.

Mr. Glenn H. Woods presented an invitation from Oakland, California, and made the promise that if the meeting was appointed to be held in Oakland, the Commercial Club of Oakland would appeal to the Commercial Club in each city to urge the Board of Education to send supervisors and pay the expenses of every teacher who attended the Conference.

Mr. Dykema appointed Mr. Farr to pass slips to discover how many had their expenses paid to this meeting.*

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*NOTE:—The results of the inquiry was as follows. 219 slips were handed in containing information on the question as to who pays the expenses of those in attendance at the Conference. Of these 166 paid all of their own expenses. In addition, 3 (one from Michigan and two from Indiana) paid their own expenses and also lost all or a part of their salaries (one of those from Indiana losing a part only) while they were away. Four (one from Vermont, one from Ohio, two from Minnesota,) paid their own expenses but stated that there was a possibility that part or all of it would be reimbursed to them later. The three representatives of the book companies who made reports stated that all of their expenses were paid by their companies. Twenty-three (four from Pennsylvania, three from Wisconsin, three from Illinois, three from Minnesota, two from Iowa, and one each from North Dakota, Mass., North Carolina, S. Dakota, West Virginia, New Jersey, Indiana, and Connecticut) stated that the Boards of Education paid a part of their expenses. This part varied all the way from a contribution of $25 to $50, to the more general arrangement of half and half or traveling expenses.

Mr. Lord, sent by the Board of Education of Evansville, urged the claims of Evansville.

Miss Alice Crane spoke for Boston. Miss Stella Root, St. Cloud, Minnesota, said that the original intent was to keep the meeting between the two ranges of mountains, as going to one extreme or the other made the Conference sectional rather than national.

Mr. Arthur Abbott had been called home, but it was stated that he had an invitation from Buffalo.

Washington was also suggested and reference was again made to New Orleans, but in the absence of both Mr. Hamlin E. Cogswell and Miss Mary Conway, and because the date of the meeting could not be arranged to coincide with the date of the Mardi Gras, neither city received any votes.

Twenty (four from Pennsylvania, three from Michigan, two from Iowa, two from Illinois, two from Connecticut, two from New York, one each from California, Minnesota, Kansas, Colorado, and Mass.) had all of their expenses paid by the Board.

To summarize then, out of 219, over ¾ (about 77%) came to the Conference entirely at their own expense.

The votes stood as follows: Oakland 60, Boston 54, Evansville 54, Des Moines 27, Buffalo 3.

Upon a second vote, the result was as follows: Boston 74, Evansville 72, Oakland 71.

The matter was then turned over to the Board of Directors to be decided at leisure, Mr. Dykema assuring the members that the difference of one or two in the number of votes cast would certainly not be the deciding element in the matter.

Mr. Gantvoort moved: That the President be authorized to appoint a committee of ten to act with the committee elected at the meeting of the Music Section of the N. E. A. in 1st, the selection of six standard songs for the various grades to be used in the introduction of music in the public schools. 2nd, the formulating of a simple statement of ideals, to predispose school boards to the introduction of music in the schools. 3rd, the selection of a list of twelve artistic unison songs suitable for use in the upper grammar grades and the High School with a view to their becoming community songs. (For list of appointees see report of Friday business meeting.)

The President appointed as a Committee on Resolutions to report at the Friday Business Meeting—Mr. Edgar B. Gordon of Winfield, Kansas, Mrs. Agnes M. Fryberger of Minneapolis, Minn., and Mr. H. E. Dann of Cornell University, Ithaca, New York.

The report of the treasurer, Mr. James E. McIlroy, was then read.

Thursday Afternoon

STANDARDS, TESTS AND MEASUREMENTS IN MUSIC TEACHING

R. H. STETSON, Oberlin College.

The development of tests and measurements has become one of the great interests for psychology today. In practical work this interest has been directed to problems like measuring the general ability of school children and measuring a special capacity like mathematical ability. There is now a psychological commission who are studying the problem of salesmanship; they hope to formulate tests for the selection of salesmen.

It is only natural that the possibility of testing and measuring special forms of ability like music should be considered. Music is based on fairly definitely marked gifts. It would be well worth while to develop tests so that one could examine a given boy or girl and say that he has the average musical ability, or less than the average or more than the average. It would be well worth while to have standards so that we could say that at a given age and at a given grade in school a boy or girl should have reached a certain attainment in music.

Such tests would be of immense importance for two reasons. They would help in deciding whether a pupil ought to make music his business, and they would help in standardizing and unifying musical instruction, and in comparing results. A beginning has been made with the problem. At Iowa State University, Mr. Seashore has established a laboratory for the study of tests for musical ability. Several other schools have touched phases of the problem. At Oberlin the presence of the large conservatory of music and of the training course for teachers of public school music and of the training course for teachers of public school music has made it an important problem for the Oberlin psychological laboratory.

But the purpose of this paper is not to announce to you what the psychological laboratories are doing or will do with the matter of testing and measuring musical ability. Rather it is to give you if possible some idea of what the work is to involve and to enlist you co-operation. The extensive work of developing tests and standards of attainment and performance will have to be done by many people, and the intelligent criticism and co-operation of practical musicians is essential.

Note the experience in other fields where such tests and standards have been organized. The best known work of the sort is the group of tests called the Binet-Simon tests, for grading school children. The method involves asking the child to answer a few test questions, to make a few simple definitions, to explain one or two simple pictures, and to repeat simple sets of numbers and words. All the material is simple so that it is portable, and the grading and standardizing is based on the results of testing thousands of Parisian school children. The Binet tests were introduced in America and have had large vogue in classifying normal and defective children, delinquents and criminals; they have been adopted extensively by school boards and criminal courts and by institutions for defectives and

criminals. During the last ten years there has been a large amount of intelligent experience with the Binet tests; thousands of children and adults have been given the tests, and the findings have been checked by practical tachers, and the history of the person tested has been followed to check the finding in later years. One of the important things to notice is that there has been a constant revision of these Binet tests. Goddard has published a whole series of minor revisions. Yerkes and Bridges have radically altered the system. Terman has published a complete overhauling of the set of tests. The tests are considerably improved; but they are not satisfactory yet. In the particular matter of detecting feeblemindness, it is possible with different versions of the tests to get from 70% to 30% in the same group tested, as Dr. Haines of the Bureau of Juvenile Research of Ohio, has shown. Dr. Haines estimates that probably the amount of feeblemindedness in that particular group of children is about 25%. The difference between normality and feeblemindedness is important, and in the course of time it will be defined by competent tests. But it is worth noting that the psychologists and the people who have to do with the practical handling and estimating of children will have to work for some further time before the Binet tests can be said to be successful.

For fifteen years there has been considerable work done to extend the Binet tests and to get tests for grades of general intelligence, so that one might grade high school and college students by their actual ability, not merely by their attainment, and so that an employer might select an intelligent man without the expense of a long and uncertain trial. As yet, nothing satisfactory has been formulated.

There have been many efforts to do something toward tests to aid in the selection of vocations. The commission for the study of salesmen are planning to give salesmen a selected list of tests for general ability. Then the salesmen will be classified by their employers, and an effort will be made to see what particular tests the best salesmen pass with high grades. Perhaps from those tests a list of tests can be made which will be of use in selecting salesmen. With the substantial co-operation of employers, the commission are devoting five years to the work, and they will be very fortunate if they have solved the problem by that time.

In some respects the problem of devising tests for musical ability should be simpler than in the case of ability as a salesman. There are certain definite gifts which may be assumed that a musician must have. This is not so obvious in the case of the salesman. On the other hand, there is an obvious standard for success as a salesman: it can be measured and compared in dollars and cents. There are many different phases of music as a profession and there is no simple and direct way of measuring and comparing success.

It is important to have in mind just what a laboratory test can do. The subject can be given a simple thing to do, and his performance of that simple thing can be measured. If you ask if a given person can learn to write 100 words per minute on a typewriter, or 150 words per minute of shorthand, or to play the accompaniment of Schubert's Erlking at 140, the person can be set to repeating a simple movement in the laboratory, a movement that he can learn in five minutes, and which will give a definite clue to the possibility of rapid movement. It happens that this rate of

movement is not improved by practice, that it is a fixed maximum rate, holding for life. Of course, no one can say if it is worth while for the person to undertake to learn to do the typewriting, shorthand writing or the piano playing at that speed. But we can say that it is possible or impossible for him ever to reach it. Unfortunately there are but few things of that type. It is possible to grade a telephone switchboard operator as to her capacity to handle numbers quickly; it is possible to show how well a street care or automobile driver will act in an emergency.

Most of the simple types of performance which can pe measured are subject to improvement by practice, and the work is rather uncertain, because you must estimate the amount of practice which this particular individual has had before being tested. And of course it is not possible to estimate an individual's future rate of improvement.

We cannot today give positive vocational guidance; it must all be negative. We cannot say what a boy or girl ought to do; but in some cases we can say definitely that the individual will not succeed in a given occupation, because we can show that he does poorly with some fundamental operation involved. We have not yet analyzed any occupation into a complete group of simple operations which we can test in the laboratory, measure, and from which we can conclude that the given boy or girl is fitted for that occupation. And of course we must always be careful not to advise on the basis of the interests or proclivities of a particular age. This is especially true of music and mechanics in both of which the child often has an intense interest. A boy whose sole interest at twelve is in music or machinery may have developed an entirely new set of interests and abilities by eighteen.

An important factor in musical ability is the capacity for improvement. No single examination can indicate this. And no quantitative method can estimate the significance of a vital interest and an intelligent purpose. The long list of musical prodigies who have come to nothing compels us to see that remarkable gifts without an intelligent purpose may mean little.

Now as to methods of developing tests of musical ability: There are two principal ways of proceeding. Mr. Seashore undertakes to apply established psychological tests to musical material; he tests the accuracy of the ear by the ability to discriminate two pitches nearly in unison, the accuracy of rhythm by the ability to detect a slight difference in the two beats of a metronome, the person's musical imagery by his capacity to hold a series of pitches in mind, the motor capacity by the repetition time already referred to. Other tests are added in somewhat the same fashion. This method is open to the danger that one will not include some of the essential elements of musical ability, and that some of the items included may be unimportant. But it can be checked by giving tests of musical appreciation, etc.

At Oberlin we have been working on a different plan. We have tried to select the fundamental elements in musical activity and then to arrange special tests for those particular things. This is open to the disadvantage that you must develop a special laboratory method for a number of the tests, instead of using familiar standard methods.

In rhythm, for example, we have made up exercises involving the fun-

damental figures and we ask the subject to execute these rhythms, grading him on his performancce. We have found that phrasing is one of the most significant indications in rhythm. We ask the subject to repeat as much as possible a rhythmic exercise after hearing it once; the difficulty of the exercise is increased until we get a measure of the subject's ability to grasp rhythmic series. We ask the subject to tap out a written rhythm; this of course is a test of reading ability and depends on training. We ask the subject to beat a given tempo for a minute to test his steadiness of tempo.

For pitch we ask the subject to name pitches, or to indicate them as well as he can, first with reference to a key, and second without reference to key. We ask the subject to match a given pitch, and hold the pitch while the piano plays a half-step above and below. We ask the subject to judge which is the higher of two tones very low and very high in the piano range. And we ask him to detect the difference between forks nearly in unison.

For melody we have asked the subject to say which is the better of two versions of the same melody, where the differences are obvious.

For harmony we ask the subject to choose the better of two progressions occurring at the end of an identical phrase. Pains is taken to make all the circumstances the same in testing melody and harmony, save the particular element tested. The tests can be given without the use of technical terms.

For musical appreciation the subject is asked to characterize two very individual phrases.

Of all these tests of musical ability, it is probable that those of rhythm are the most fundamental. How much a musician's ability to handle pitches should count is a question; individuals differ widely and we need expert observation of musicians as to its place in musical capacity. Moreover in making the test, a great deal depends on the subject's training for pitch.

We are at present working on a method of testing pitch by using the intonations in speech as a test. The meaning of the sentence often depends on the pitch relations. Each person can be presumed to have about the same practice in hearing and producing these pitch relations of speech.

Material for harmony and melody is especially difficult to standardize. It depends to a great extent on the experience of the subject. In general we have made the ordinary four-part harmony of the conventional type the basis—assuming that the harmonic experience of hymns and other forms of choral music will be the range of the subject's experience.

There are two things in which the co-operation of music teachers and other professional musicians is to be important. In the first place we need to know the relative importance of certain types of capacity connected with music. Is an accurate ear for pitch essential? Does the memory for melodies indicate musical capacity? How important is musical imagery by which the person is able to form some notion of the sound of a composition when he reads the notes? We need a large number of tests of developed musicians, checked by the judgment of musicians to determine such points.

In the second place we must have a large collection of records of music students giving their standing by a group of tests at the beginning of training. The group of tests must be simple enough to be administered in

any public school or musical institution. And these records must be checked up by the experience of teachers with these pupils, and by their success in after life as musicians. This will demand the intelligent testing of the tests, and the verifying of their findings. In time we can hope to have standards, tests, and measurements of musical ability which will be of great value to music teachers and to people choosing a vocation. But it will take time and intelligent and active interest, not only on the part of psychologists with insight into musical problems, but also of teachers of music, and of other professional musicians.

Round Tables

The topics of the Round Table Discussion for Thursday afternoon proved so interesting that a desire to attend several of these meetings was being expressed by many. The President felt that the purpose of these Round Tables might be defeated and requested an expression of preference. Papers were prepared, and passed through the house, and topics preferred were marked with first and second choice. The results of the vote were tabulated and read by the President at the luncheon group of officers and advisory council. This report showed so few notes for fine topics that it was decided to omit them and announce the remaining seven topics for discussion. The following is a report of these Round Table Discussions as presented by the various Secretaries of the Sections.

ROUND TABLE NO. 1

The Voice of the Boy—with special reference to the four years from age 11 on.

Father W. J. Finn, *Chairman*, Chicago, Ill.

Father Finn gave a brief exposition of the three representative schools for the training of the boy voice. Having emphasized the fact that all three schools agree on two points—namely, downward vocalization and pianissimo practice for the first half year—he pointed out the distinguishing characteristics of the three schools.

The Westminster School especially stresses downward vocalization, utilizing only the upper register and completely discarding the middle register.

The Varley Roberts School trains the upper and middle register separately with the result that the boy's voice shows two distinct qualities analagous to the tones resulting from the use of different stops on the pipe organ.

The third school (of which Father Finn is an exponent) is represented by Mr. Walter Henry Hall and is distinguished by a method termed scientifically correct. It provides for the blend of the two registers. This blend makes possible the use of the most effective tones—those in the middle register—and gives a range of three octaves. Furthermore, by this method the boy's voice may be trained through mutation. Both of the other schools suspend training during mutation.

Father Finn next described the training of the voice during mutation. The boy is gradually placed on the lower parts by being allowed to sing suc-

cessively on the first soprano, second soprano, first alto, second alto, etc. After the break, the voice is trained by approximately the same method used in training the boy soprano.

The Chairman then called on Mr. Duncan McKenzie, of Montreal, Canada, who was trained in Varley Roberts' school, and who did not endorse all of Father Finn's remarks. He believes that the training of the boy's voice through mutation is impossible and does not require that they sing at this time. At the request of Father Finn, Mr. McKenzie upon returning to Montreal wrote out his ideas in detail.

Discussion by Duncan McKenzie, Montreal, Canada.

Father Finn's great point was to "look to the middle register or so-called chest voice" and to remember that the boy has one during the years before adolescence. He maintained that by eliminating this voice and training only the head voice, after the break or change to the adult voice comes, he is liable to be without the voice nature has given him, and which is characteristic of the male adult voice, namely the chest voice. Is this true in all cases or the majority of cases, is it sufficiently true to justify breaking the traditions of training the head voice before adolescence? In the case of choir-boys undergoing early training and using their voices as much as they do, it often is, but not so often as to be the most general case; in schools where singing is one subject in the curriculum I find it is not the case. Here the training of the head voice only does not mean the elimination of the chest voice in adult life.

What kind of voice training therefore is best to attain artistic results with the boy's voice; to preserve it and to make use of all nature has given him so that he can have the best voice nature has given him, in an undamaged condition? Undoubtedly the best results can be obtained in quality of tone and in blend by training the head voice only. The quantity of tone in the lower part of the voice can be developed so as to seem almost the same as that produced by the chest voice if the training has taught the boy to control and concentrate on the intensity of the tone, the result being an approximation to the luscious tone of the real alto voice. This suffices for unison and two part singing. With three part singing a much lower range is necessary and the use of the chest is also necessary and desirable. Hence use it, but only because he can use the head voice at will and because the head voice does not give him the results he wants to meet the occasion. The training of the chest voice must be done just as carefully and logically as is done the training of the head voice.

The danger of using the head voice in the wrong place, and the reason for not training it first must be treated for the boy's sake and understanding from a commonsense point of view, and he must have a proper appreciation of when to use and how to use the one or the other socalled voices. Thus he is enabled to use all the voice nature has given him in his boyhood, so that in manhood his early training has equipped him vocally for manhood. Also it is thus possible to get an approximation of the luscious, rich tone of the female alto and so make three part singing justifiable, which the use of the head voice in many cases does not.

The main reason for not using the chest voice is generally lack of blend. But if the training is such that the boy can mentally adjust his voice so as to fit in with the other voices and aim at blend, the reason will

almost gradually disappear. Another reason put forward is the chest voice lacks the quality of tone of the head voice. This will also disappear if the mental side of the training and use of the voice is emphasized. The result will depend on the time, the care, and the proper use of the voice. Some unison songs are in fact more effective in the chest voice than in the head voice. Why not use it, but not abuse it?

For practical school work I find the most common sense plan is to use and train the head voice only in the early stage, aiming at developing the lower part of the voice to approximate the chest voice in quantity of tone. Then work on the chest voice, compare with the head voice, note its limitations and its usefulness. Show the boy how to manipulate the change from the one voice to the other to make his voice homogeneous. Make him appreciate your method of working, and let him use all the resources nature has given him in their own proper way. Show him the danger of misusing these resources.

As to Father Finn's singing a boy through the break, this is possible in few cases in school. At the period of actual change, individual examination and constant advice from the teacher is necessary. For a short period—which varies in length—I recommend entire rest. When the boy feels he again wants to use his voice, let him consult the teacher that day. Name his voice for him if it can be named, give him to understand when to use it and what limits or not to use it. The classification is more minute than bass, baritone and tenor. As to using the counter tenor voice up to 22 or 23 years of age, I would permit it for the sake of getting notes out of his reach otherwise, but I would not develop the voice until I have developed the male voice proper to a good extent, as this is not the natural voice which makes us acknowledge the use of the chest voice in boyhood. Train the counter tenor later in life.

Father Finn was asked to describe his method of breath control. He leads the boy to observe the natural habits of breathing when he is unhampered by artificial conditions.

Mr. T. P. Giddings of Minneapolis spoke next. He uses essentially the same ideas endorsed by Father Finn, although he finds it impossible to carry the development so far in Public School Music. However, in pointing out differences between the field of the choir-master and that of the Public School music teacher with his more limited opportunity for the training of the child voice, Mr. Giddings emphasized his belief that every bit of singing should be an exercise that tends toward the attainment of a more perfect tone quality.

The meeting then adjourned.

Helen Boswell, *Secretary.*

ROUND TABLE NO. 2

Orchestra Music for Public Schools

MR. WILL EARHART, Pittsburgh, Pa., Chairman

At the Lincoln meeting of the National Conference of Music Supervisors a special committee was appointed to prepare a recommended list of orchestral material for public school orchestral work. In the four issues of the Music Supervisors' Journal since that meeting lists have been published, the first three prepared by Mr. E. B. Gordon of Winfield, Kansas, Chairman of the Committee, the fourth, for elementary schools, by Miss Jennie L. Jones, Supervisor of orchestral music in the Elementary Schools of Los Angeles. They are here reprinted at the request of Mr. Will Earhart, Chairman of the Round Table Discussion of Band and Orchestra Material.

ABBREVIATIONS.

O. D.—Oliver Ditson, Boston.
C. F.—Carl Fischer, New York.
B. F. W.—B. F. Wood, Boston.
G. S.—G. Schirmer, New York.
E. A.—Emil Ascher, New York.
J. P.—Pepper & Son, Philadelphia.
W. M. C.—Willis Music Co., Cincinnati.
L. F.—Leo Feist, New York.
S. F.—Sam Fox, Cincinnati.
W. & S.—Whitmark & Son, New York.
J. W. S.—Stern & Co.
J. & S.—Jenkins & Sons, New York, Kansas City, Mo., etc.
F. B.—Fillmore Bros., Cincinnati.
Q.—Quincke, Los Angeles.
J.—Jacobs, Boston.
G. P.—Gearen Pub. Co., Chicago.
M. L. C.—M. L. Carson, Chicago.

List No. 1

COLLECTIONS

The School and Community Orchestra, Bk. I. Gordon— .... W. M. C.
Peerless Beginner's Orchestra Album, Paul De Ville .... C. F.
The School and Community Orchestra, Bk. II. Gordon .... W. M. C.
The Community Orchestra (Easy arrangements of well known pieces) .... W. M. C.
Carl Fischer Favorite Concert Album (More difficult) .... C. F.

SINGLE PIECES.

Selection.	*Composer-Arranger.*	*Publisher.*
Apple Blossoms	Roberts	L. F.
Choral from "St. Paul"	Mendelssohn	L. F.
Sunset	Brewer	S. F.
Rhodora	Devaux	B. F. W.
A Bunch of Violets	Bennet	O. D.
Feast of Lanterns	Bennet	O. D.
Fifteen National and Patriotic Airs		O. D.
In Beauty's Bower	Bendix	W. & S.
Laces and Graces	Salzer & Bratton	W. & S.
The Land of Romance	Hoschna	W. & S.
Lords and Ladies	Salzer	W. & S.
Whispering Willows	Herbert	W. & S.
Hobomoka	Reeves	J. W. S.

Glowworm	Linke	J. W. S.
Softly Unawares	Linke	J. W. S.
Fire Flies	Linke	J. W. S.

List No. 2

COLLECTIONS.

Sunday Music Collection—O. D.
Ten Light Overtures for Orchestra—O. D.
The Paramount Orchestra Folio—O. D.
Amateur Concert Album in V. Vol. arranged by Tobani, Isenman, Lilenberg C. F.

SINGLE PIECES

Minuet in G	Beethoven	C. F.
Nocturnal Piece	Schumann	C. F.
Forget-me-nots	Englemann-Tracy	O. D.
Moonlight Wanderings	Bennet	O. D.
A Passing Fancy	Rollinson	O. D.
The Chapel in the Mountains	Wilson	O. D.
Campus Echoes	Rollinson	O. D.
Nekayah (Entr' Acte)	Gruenwald	O. D.
Youth and Beauty (Polonaise)	Rollinson	O. D.
The Wayside Chapel	Wilson	O. D.
Antony and Cleopatra Suite	Gruenwald	O. D.
Largo	Handel	C. F.
Carmen March	Bizet	C. F.
Vision of the Stars	Von der Mehden	C. F.
Poupee Valsante	Poldini	C. F.
Flora, Overture	Schleppegrel	C. F.
Processional March	Tracy	O. D.
Invocation, chorus and March from "Iolanthe"	Sullivan	O. D.
Minuet from Military Symphony	Haydn	C. F.
Lustspiel, Overture	Keler Bela-Rollinson	O. D.
A Twilight Romance (Cornet Solo)	Bennet	O. D.
Awakening of Spring	Lange	O. D.
Flower Song	Bach-Rollinson	O. D.
Bubbles (humoresque)	Gruenwald	O. D.
Operatic Echoes	Gruenwald	O. D.
Humoresque	Tschaikowski-Rollinson	O. D.
Parade of the Manikins	Rudolf Wagner	O. D.
Cerisette Polka (Cornet Solo)	Rollinson	O. D.
Selection from "Norma"	Bellini-Gruenwald	O. D.
Gems from Maritana	Wallace-Bennet	O. D.
Caliph of Bagdad	Boldieu	C. F.
Stradella Overture	Flotow	C. F.
March from "Aida"	Verdi	C. F.
Bohemian Girl, Selections	Balfe	C. F.
Cavatina	Raff	C. F.
La Cinquantaine	Gabriel-Marie	C. F.
Humoresque	Dvorak	C. F.

List No. 3

Spring Song	Mendelssohn	C. F.
Evening Song	Schumann	C. F.
Nocturna	Chopin	C. F.
Pizzicati Polka	Delibes	C. F.
Selection from "Pinafore"	Sullivan	C. F.
Selection from "Mikado"	Sullivan	C. F.
Song of the Volga Boatmen	(Russian folk song)	C. F.
Post im Wald	Schaffer	C. F.
Serenade	Schubert	C. F.
By the Sea	Schubert	C. F.
Al Fresco, Intermezzo	Victor Herbert	W. & S.
An Esquimo Wedding (Suite)	Frinkens	W. & S.
Arabian Twilight (Oriental Caprice)	Luscomb	W. & S.
The Busy Bee	Bendix	W. & S.
Chiffon (Suite)	Moore	W. & S.
The Dervishes	Bendix	W. & S.
Dream Shadows	Langey	W. & S.
Entre' Acte from Mlle. Modiste	Herbert	W. & S.
Hindoo Priests	Bendix	W. & S.

List No. 4

MARCHES

*Our Boys and Girls of California	E. A.
*Boys' Brigade	E. A.
*Cadets' Drill	E. A.
*Bugle Boy	E. A.
*Return of the Volunteers	E. A.
Yankee Boys	E. A.
Record—	E. A.
Wien bleibt Wien	E. A.
*Norma	E. A.
American Conquest	E. A.
*On the Wing	J. & S.
‡Snow Boy: Matinee	F. B.
The Jonares: Fort Royal	F. B.
‡Loyal Guards	Q.
‡Co-ed: School Life	S. F.

WALTZES

Woodland	J. & S.
Reign of Roses	J. & S.
Dawn of Beauty	J. & S.
Fleur d' Amour	J.
Dream: Lola: Lilac	E. A.
Simplicity	G. P.
El Ontono	Q.
Celeste	Q.
Evening Shadows	M. L. C.

DANCES, MAZURKAS, ETC.

Dance of the Honey Bees	E. A.
Cupid's Garden	E. A.
Garden of Roses	E. A.
Delightful	J. & S.

Marked * 1st position violin. Marked ‡ nearly all 1st position.

Marche aux Flambeau	Scotson-Clark	C. F.
Festival March	Mendelssohn	C. F.
March Pontificale	Gounod	C. F.
Golden Sceptre Overture	Schlepegrell	C. F.
William Tell Selection	Rossini-Seredy-Tocaben	C. F.
Remembrances of Waldteufel	Seredy-Tocaben	C. F.
Victorious Legions March	Seredy-Tocaben	C. F.
Wedding March (Mendelssohn	Seredy-Tocaben	C. F.
Barcarole from Tales of Hoffmann	Seredy-Tocaben	C. F.
Il Trovatore Selection Verdi	Seredy-Tocaben	C. F.
Straussiana Waltz	Seredy-Tocaben	C. F.
War March from Atalia	Mendelssohn	C. F.
Minuet from "Bernice"	Haendel	C. F.
Silver Bells, Gavotte	Isenman	C. F.
Egyptian Midnight Parade	Isenman	C. F.
Fairy Tales (Maerchen)	Komzak	C. F.
A Musical Dream	Isenman	C. F.
The Iron Cross	Isenman	C. F.
Solemn March (from "Joshua")	Haendel	C. F.

Mr. Earhart called attention to various features of the above list and stated that in his opinion, while there were undoubtedly some numbers about which there would be discussion, the list, in the main, was decidedly helpful. Much free discussion followed, most of it being merely short questions and answers. Three of the gentlemen, however, spoke more at length, somewhat as follows:

D. H. Cleland, Supervisor of Music, Cleveland High School, St. Louis, Mo., Mr. Chairman: Your suggestions that the orchestra be taught a singing style emphasizes the great importance of the playing of accompaniments for choruses. Instrumental playing from the first has been developed with the voice, and the association of any instrumentalists with singing will always result profitably.

Charles E. Griffith, Jr., 278 Alexander St., Rochester, N. Y., Mr. Chairman: Has any supervisor known of Breitkopf and Haertel's edition for four violins of the best concert selections from Lohengrin and Tannhaeuser? These are ideally suited for violin clubs in the grades, one to ten instruments on a part. The difficulties are not great, and the results are encouraging alike to pupil and instructor.

May I submit a list of orchestra music in which the second violin parts have melodic value? These numbers are "Lancelot" and "Liselotte" by Adam, both of which are light and yet worthy enough to be played by the Boston Symphony at their "pops"; "Albumblatt" by Wagner, Introduction to 3rd act "Die Meistersinger"; overture to "King Manfeld"; Remicke,

"Forget-me-not", Macbeth, and for a rather advanced orchestra "Ballet Egyptienne" by Lingini.

Donald Heins, Ottawa, Can.: I want to put in a plea for the foundation of a more serious view of music from the earliest stages of study. I venture to suggest that harmony, i. e., playing together in parts, becomes more absorbingly interesting than melody played in unison. I go the whole way with Dr. Mitchell of Boston, in his splendid work on the beginnings of violin playing for use in the public schools. However, when Section 3, page 16, is reached, the students would be ready for the following amendment. That simple rounds, catches, and canons could then be used, introducing a feature of regular orchestral work, counting the rests and making correct entries and so on. After this would follow increasingly elaborate passages such as may be found in the works of Handel, Correlli and Bach. These could easily be simplified without forsaking the outline and entire numbers such as suites and choruses employed, At this point I should like to make clear the distinction between a string orchestra, and a full or complete orchestra. For many reasons the latter is impracticable in schools. Music arranged specially for strings, together with many splendid compositions written purely for string orchestra, is however, much in use, and for school orchestras of paramount importance. Such music is far better adapted to broadening out style than pieces of purely melodic interest, which in many cases serve to vitiate the taste, and write *rubbish* upon these clear waxen mental surfaces.

Further, the teacher's attention would not be drawn off by playing accompaniments. The teacher would be conducting an orchestra, from the beginning.

In every school, I would offer free private tuition to a limited number of pupils who would study the viola, cello, and bass, *if practicable*, stimulating them to a somewhat more rapid advancement in order to be of service to the school orchestra. From this would follow the adaption of numerous quartettes and early symphonies by the great masters, Hayden, Mozart and others, in chronological order if possible.

In this way one would be reconstructing the musical ideas from their more incipient stages up. Ideas of form would grow upon the student, together with a logical progression in technique. Obviously technical performance *has* progressed in response to the demands of composers, as their ideas swept forward. In the styles of composition to which I have referred wind instruments in many cases are employed. The wind parts could be arranged easily, so that the less efficient players could perform them. They should be carefully edited, fingered, bowed and phrased, being adapted to the need of the moment, whilst completing and filling out the work.

I believe that from numbers of boys and girls, talented young men and women would arise in every community, who would carry on the work after school days as conductors of orchestral clubs and societies.

Others would be stimulated to study wind instruments in order to gather the colour to be gained from complete orchestral effects.

Not the least advantage of all this musical activity would be the opportunity offered in later life to many who have progressed far upon the technical road, yet who through temperamental lack, or nervous shortcomings, could never be acceptable as soloists. Such are at present unable to

express themselves without invoking all the spirits of unrest. They naturally find it difficult to get any efficient person to give up time to accompanying their painful efforts, and end by losing interest, thus falling, green, and withered, from the music tree. In closing I must call attention to three points. First, the great importance of minute technical drill, from the actual position of performance, up to the rehearsal of drills, scales and thirds, etc., for development. Second, that the classes should meet *daily* for practice, so vast is the field to be covered. Third, that the teacher should realize that he or she must inspire the pupils to be the kind of people who make good musicians. I dare not enlarge upon this awe inspiring subject, beyond stating that it is by personal example mainly if not only, that this can be accomplished.

The meeting, for lack of time, adjourned in the midst of a lively discussion.

Ada E. Bicking, Evansville, Ind., *Secretary.*

ROUND TABLE NO. 3

TOPIC: MATERIAL FOR PUBLIC PERFORMANCE BY PUBLIC SCHOOL CHILDREN

Discussion along the general lines of the address by Irving W. Jones, University of Wisconsin, delivered at Lincoln Conference, March 1916. (Journal of Proceedings pages 110 to 122).

HOLLIS E. DANN, Ithaca, N. Y., Chairman

Mr. Dann: That this meeting may proceed along definite lines, without loss of time, the following statements are offered as a basis for discussion.

Public performances of music by children in the public schools should be under proper control and supervision, thereby safeguarding the interests of the child and the school. The following conditions are deemed essential:

1. The music, however simple and light, should be of a character which promotes a taste for an appreciation of real music values.
2. The music shall be such as to make possible a reasonably adequate performance. The music should always be adapted to the mental, emotional and vocal capacity of the children participating. Music involving extremes in compass either very high or very low or which demands great volume for adequate performance should be avoided.
3. As far as possible the preparation for public performance should be made during school hours as a part of the course in music. Public performances which by their character or frequency divert interest and attention from the normal work of the school should be avoided.
4. The more elaborate solos in the high school concerts should usually be sung by adults, alumni if possible, and should be done in the most artistic manner possible.

The material chosen for the regular work and public performance by

the schools, sets the standard and forms the ideals of the children, and very materially influences the musical taste and ideals of the entire community. A wise selection of material for school purposes for all grades and occasions is a long step toward the formation of correct ideals and right habits and goes far toward the realization of ultimate aims in music education. It is a matter of supreme importance to the supervisor to know what is suitable and desirable and what is worthy and harmful.

The young supervisor does not always know how to proceed to secure a variety of material and finds difficulty in judging of its merit. To such the following suggestions may be helpful.

1. Get in touch with publishers; they will co-operate with you. Carefully examine music which seems excellent and suitable for your needs.
2. Take at least two or three musical papers and magazines which print programs. Send for the compositions that look promising but dont give them because someone else does.
3. Take every opportunity to hear good programs under the direction of authoritative conductors.

The supervisor should make a study of program-making. It is an art. The paper, type, arrangement, program notes, length, unity contrast, are important details. No feature of the supervisors' work offers a better opportunity to prove the possession of good taste or the lack of it than the choosing, arranging and printing of a program of music. Very much may be learned by observation, by collecting and studying programs made by those who are experienced and skillful in the art.

The task of selecting music material and preparing it for public or semi-public performances by children demands—

An intimate knowledge of the child voice and of the adolescent voice;
A wide acquaintance with the music literature suitable for the many different requirements;
An unalterable determination to use only material which has real educational value;
A keen appreciation of the true aim of music education and a proper perspective of its relation to the school curriculum;
A will to place the welfare of the child above personal ends and ambitions.

Only these high ideals and a will strong enough to live up to them, will keep the supervisor from sacrificing the educational to the spectacular. It requires a high degree of moral and professional courage to keep the supervisor in the path leading to real music education and to keep him out of the show business.

Above all, if we would win and hold the respect and co-operation of musicians and of other people whose judgments concerning music education are best, and if we would conserve and promote the best interests of the great body of young people for whose musical education we are responsible, let us avoid mutilated arrangements of great music which cannot be adequately performed by children.

Occasion for public performances practicable for most communities are as follows:

1. Schoolroom entertainments.
2. Christmas Carol Services.
3. Grade and High School Concerts and Festivals.
4. Musical Competitions.

1. SCHOOLROOM ENTERTAINMENTS

Musical and literary programs made up of recitations, short plays or operettas, solos, duets, choruses, school orchestra, etc.

Material in the form of operettas, musical plays, etc., is published in great profusion, yet very little is suitable from a musical standpoint. Sometimes the literary and dramatic features are good while the music is utterly unsuitable and often positively harmful. These plays and operettas are usually constructed by people who do not know the child voice and who make all sorts of serious mistakes in their attempt to provide music for otherwise meritorious creations. The grade teacher should not be entrusted with the selection.

All material for public performances should have the approval of the music supervisor who should be able to suggest suitable material when he is obliged to disapprove the teacher's selections. Sometimes the music is good and the compass very bad. Changes of keys and therefore of the compass of the songs is in such cases all that is essential. ("Santa Claus and Mother Goose" by Jessie H. Brown, published by Fillmore Bros. well illustrates this type. The music consists of good German folk tunes transposed into keys suitable only for the low alto voice. No teacher can possibly use such a compass with young children and maintain musical tone quality.) The mere novice in school music nowadays knows that the usable and safe compass of the child voice is approximately that represented on the treble staff without leger lines.

Makers of operettas take strange and unwonted liberties with music. The best known and best loved tunes are ruthlessly divorced from their texts and clandestinely wedded to original poems, thus doing violence to the fusion of lyric poem and music. An example of this type of school entertainment appeared recently in "The Normal Instructor and Primary Plans" entitled "Mother Goose's Garden". Barring the music, the operetta is a charming creation. Groups of children impersonate Roses, Lilies, Grasses, Tulips, Violets, Daisies, Johnny-Jump-Ups, Buttercups, Arbutus, Daffodils, Daisies, Butterflies, Sunbeams, Bees, Bluebirds and Raindrops. The tunes, all to original poems include: "Jingle Bells, A Warrior Bold, My Bonnie lies over the Ocean, I Cannot Sing The Old Songs, Blue Bells of Scotland, Sweet Afton, Maryland, My Maryland, Annie Laurie, The Miller of the Dee and Aura Lee. The supervisor and grade teachers of a certain city found in their regular music readers real children's songs about the Rose, Violet, and Johnny-Jump-Up etc. and substituted these for the old tunes. Thus the operetta was charmingly given with beautiful and appropriate music which was learned during school hours as an integral part of the work in music.

2. CHRISTMAS CAROL SERVICES

This is a most delightful form of public performance for children, suitable both for the grades and for the high school. It is desirable to gather from year to year a repertoire of twenty to thirty Carols, repeat-

ing some of them each year thus making them familiar to the entire community. Books of carols and octavo editions of separate carols are available.

Material for Soprano and Alto Chorus

Music originally written for children's or women's voices is obviously preferable to arrangements of music intended for other voices. There is such a large and varied amount of excellent and attractive material in this field that it is not necessary to use arrangements or adaptations to any extent.

When arrangements for any combination of voices are made they should not do violence to the original harmonic structure, much less should they take liberties with the composer's melody. We have no right to mutilate the work of a worthy composer and we have no right to teach children inferior compositions. Therefore we are bound to respect and follow certain well defined limitations concerning all "arrangements". The following cantatas for Chorus of Sopranos and Altos are good examples of music suitable for school performance:

Pan on a Summer's Day—Paul Bliss—Willis Music Co. Chorus, two sopranos and alto, piano accompaniment, orchestrated suitable for Junior High School or High School.

King Rene's Daughter—Henry Lahee—Novello & Co. Chorus, first and second soprano and alto, piano accompaniment, soprano, mezzo soprano and alto solos.

Legend of Bregenz—Wilfred Bendell—Novello & Co. Chorus, first and second soprano and alto, piano accompaniment, soprano solo.

Lady of Shalott—Wilfred Bendell, Novello & Co. Chorus, first and second soprano and alto, piano accompaniment, soprano solo.

Garden of Flowers—Luigi Denza—Novello & Co. Two and three parts, piano accompaniment, solos, alto, mezzo soprano and soprano.

Material for Girls' Choral (Glee) Clubs

Octavo Music, different publishers.

The material should be unison, two-part and three-part, accompanied.

NOTE:—The lists of material which follow are intended only to illustrate types of suitable music and are necessarily incomplete.

Cantatas for mixed voices—High School (with or without orchestra.)

King Harold—F. Cunningham Woods—Novello & Co. Soprano and tenor soli, chorus of mixed voices and orchestra. Founded on historical novel "King Harold", Lord Lytton.

Wreck of the Hesperus—Thomas Anderton—American Book Co. Soprano, tenor and baritone soli, chorus, mixed voices, orchestra.

The Mound Builders—Paul Bliss—Willis Music Co. Soprano, alto and bass soli, chorus and orchestra.

Hero and Leander—Chas. H. Loyd—Novello & Co. Soprano and bass soli, chorus and orchestra.

Building of the Ship—Henry Lahee—Ditson & Co. Quartet of soloists and chorus.

Gallia—Chas. Gounod—Novello or Ditson. Soprano Solo, Chorus and Orchestra.

Choruses—Mixed Voices

Birthday of a King—Neidlinger.
Blow, ye gentle breezes—Christopher Marks.
Bridal Chorus, "Rose Maiden"—Frederick Cowen.
Carnovale—Rossini.
Damascus Triumphal March ("Naaman")—Michael Costa.
Gypsy Life—Robert Schumann.
How Lovely are the Messengers "St. Paul"—Mendelssohn.
To Thee, O Country—Julius Eichberg.
Daybreak—Eaton Faning.
Goodnight, Beloved—Ciro Pinsuti.
Love and Summer—John E. West.
Song of the Vikings—Eaton Faning.
The Indian Maid—J. L. Hatton.
The Miller's Wooing—Eaton Faning.
The Sands of Dee—G. A. MacFarren.
The Sea Hath its Pearls—Ciro Pinsuti.
Volga Boat Song—B. C. Tuthill.
Farwell to the Forest—Mendelssohn.
O, My Love's Like a Red, Red Rose—G. M. Garrett.
Swedish Peasants Wedding March—Aug. Soderman.
At Evening—Jules Massenet.
Also numerous and well known books for high school choruses.

Separate Choruses for Chorus of Sopranos and Altos

The octavo publications of two-part and three-part choruses are very extensive. There are several excellent books also containing a wealth of good material. Four-part music should be avoided for obvious reasons. The ideal type is illustrated by the "The Sunworshippers" (Zuni Indian Melody) Birchard & Co.

Publishers of Music Material for Schools

American Book Co., New York, Cincinnati and Chicago.
C. C. Birchard & Co., Boston.
Columbia Phonograph Co., New York.
Oliver Ditson Co., Boston and New York.
Edison Co., New York.
Eldridge Entertainment Co., Franklin, O., Denver, Col.
Carl Fischer, New York.
Ginn & Co., New York and Boston.
The H. W. Gray Co., (Novello & Co.), New York.
Scott, Foresman & Co., Chicago.
Silver, Burdett & Co., New York and Boston.
G. Schirmer (Boston Music Co.), New York and Boston.
Arthur P. Schmidt, New York and Boston.
Clayton F. Summy, Chicago.
Victor Talking Machine Co., Camden, N. J.
Willis Music Co., Cincinnati, O.
Educational Music Bureau, Chicago.
Supplies all publications. Not publishers.

ROUND TABLE NO. 4. The SCHOOL SURVEY

J. BEACH CRAGUN, *University of Chicago, Chairman*

Mr. Cragun briefly sketched the rise of the survey movement, much as he outlined it in his paper presented in the January, 1917, Music Supervisors' Journal. The closing was as follows.

You ask, in how far, to what end and in what way may these survey test methods be applied to public school music. This is very much open to discussion and brings up a phase of the matter beyond the limits set for the present paper. However, a few explanations here may be of great importance. It is to be remembered that such methods of measuring results as those mentioned or hinted at above may be applied only to the formal side of any given branch of instruction. The inspirational phase, whether of English, literature, music, or what not, does not lend itself to systems of measurement. As a result it is certainly true that the methodology employed by the school survey is more applicable to some studies than to others, but it is none the less certain that whatever phase of a given subject may be covered in this way is going to be subjected to some scientific processes of evaluation.

Since school systems are being more and more subjected to the social invoice of the school survey, and since music is certain to be brought beneath the light of this kind of investigation more and more, some of us must make it our business to work out principles under which our subject should be so scrutinized, and methodology whereby this scrutiny may bring results representative of the ability of the children. Allow me to be specific in this detail. It was stated above that the formal side of a subject is that which has been most considered by school survey. The formal phase of music instruction may be said to come mostly under the head of sight reading. If this be so, methods of testing which will truly represent the sight reading ability of the children must be worked out. If there be other formal phases, tests should be devised which cover them as well.

The school survey is established. Its application has had significant results. Its methodology may be faulty, but it is beyond question being rapidly and materially improved. The limits of its application to public school music, and the methodoloy of its procedure within these limits are open questions with which it behooves us to concern ourselves.

Various means of conducting a "School Survey in Music," were suggested by different supervisors in attendance at the Conference.

Mr. Walter Aiken of Cincinnati, was of the opinion that some one be appointed as a member of the committee who was a thorough observer of children, rather than a musician.

C. H. Farnsworth, of New York City, suggested that such a person be *not* a supervisor, but thought that it should be someone connected with music.

Miss Frances F. Brundage of Chicago was of the opinion that someone entirely outside the public school work—preferably a private teacher, but acquainted with the teaching of music to children, and who has made a study of children— be made a member of such a committee.

Others taking part in the discussion were: Professor Raymond H. Stetson of Oberlin, Ohio, Mr. C. H. Miller of Lincoln, Nebraska, Mr. E. B. Birge of Indianapolis, Indiana, and Miss Laura Soper of St. Louis.

It was the unanimous opinion of those present that the present chairman, Mr. Cragun, confer with the incoming president, to further investigate the matter of the School Survey during the coming year.

Ella M. Brownell, *Sec'y.*, St. Johnsbury Vermont.

Note: The committee appointed to carry on this work is J. Beach Cragun, Chicago, Ill.; John W. Withers, St. Louis, Mo.; Charles H. Farnsworth, New York City; Will Earhart, Pittsburgh, Pa.; and Peter W. Dykema, Madison, Wis.

ROUND TABLE NO. 5

Harmony Classes in the High School

CAROLYN ALCHIN, Los Angeles, Cal., Chairman

Miss Alchin: There is an increasing demand nearly everywhere for a more intelligent study of music; a broader, deeper appreciation; more power in expression and interpretation. There is no branch of music study that can contribute as much to these things as harmony—when studied in a practical way, treating the subject as a study of *tonal effects*, instead of a blind observance of arbitrary rules mathematically applied.

With the advantage of daily lessons, the high school teachers have a better opportunity to teach harmony successfully than any private teacher or one in a music school where the student takes but one or two lessons a week.

Given teachers who are *real musicians* with ability to teach that particular subject, the high schools can lead the world in this branch of music education. The course can and should be so exhaustive and thorough that supplementary work outside of the school will be unnecessary.

Notice that I have mentioned the first and in my judgment, the greatest difficulty—having the right teacher. So often the harmony work is given to one who happens to have a spare period. Because one can teach voice or direct a chorus successfully, it does not follow that he can teach harmony. How often do we hear this: "Oh, she is *so* sweet and dear." One needs a stronger equipment than that.

In discussing the subject today, let us consider the *Whats*, for what should be *can* be, and yesterday's best is not good enough for today. When the *Whats* of teaching are decided, we can spend the remainder of our teaching existence on the *Hows*.

Music is a matter of *ear* and *feeling*, and as far as the study of harmony contributes to these things it is valuable. When it ceases to appeal to the music sense, it ceases to belong to music education.

Every bit of the writing, no matter how *small* the exercise, should be something perfect in itself, something that could be embodied in a serious composition. We require that in language; why not in music? That eliminates the reams of worse than useless stuff that students are sometimes required to write for the so-called foundation, and which has no place in a work of art.

Returning to the statement that *music is a matter of ear and feeling*, I want to say in capital letters that the first commandment in the study of *any* branch of music is *Rhythm*, and the second and third are like unto it. *No rhythm, no music.* The late Julius Klausen said: "The study of music

is the study of relationship." When we find the various relationships in the study of harmony, we have all of the *Whats*, so relationship may be the cornerstone of the work; first, the material of music, melodically related in key; then to chord-root; to harmonic and rhythmic cadences; the relation of harmony to rhythmic accents; of chord to chord in key; of sections and phrases, and the relation of keys.

When one hears and feels the harmonic substructure of a melody, he hears both the scale and chord relation. For example, simultaneously with the recognition of the scalefourth, one might hear it as chord root, chord third, fifth or seventh. A simple application of the overtone relation makes it possible to select inversions that are always good, simultaneous with the recognition of the other relations. From the beginning, the work should be so directed that *tone-thinking* and *feeling* are not only possible but *unavoidable*. Understanding and feeling the *nature of music* which is the product of relationship, one has a basis for skill, the same as in language, or as the chemist, who must first understand the nature of his material before discoveries are possible.

Not *one* of the things I have mentioned is impossible for the high school student who is properly *prepared* for the study of harmony. That brings us to a very important phase of the work which I hope will be seriously considered today. What preparation shall we require? To start the discussion, I will say: *sight singing*, *tone-thinking*, and *some pianistic ability*. If one is unable to *think* tone, the work is a mechanical process, and a dead language as far as that student is concerned. Referring to the key-board work, it is absurd to know harmony on paper only: an ounce of application is worth a pound of theory. Of the pitfalls for the beginner, I want to emphasize that of writing with no idea of relation to rhythm accents. Another pitfall is the persistent use of root basses; another, the long-continued practice of harmonizing every note, and thinking from note to note instead of in phrases.

The best way to kill interest and cultivate habits of mechanical work without the exercise of feeling and judgment, is to write from a harmonic prescription above a string of bass notes that is not a melody and is without form. Another mistake is the employment of every chord in key from the beginning. To introduce the material progressively is not only good pedagogy but the work is very much easier. The student acquires a finer discrimination in tonal effects, and the ability to think in four parts that is almost impossible for the large majority of students.

Discussion of the question,—What preparation shall the student entering a course in Harmony have had?

Miss Alchin: Sight singing, tone-thinking and some pianistic ability.

Mr. Hawley, Westfield, Mass.: The singing and hearing of melodies throughout the grades is sufficient preparation. Piano-playing is desirable, but not necessary. Many violinists or non-instrumentalists prove better harmonists, because they are obliged to think more independently.

Mr. Zanzig, New York: Besides skill in notation and hearing, and in creative conception of melodies, experience in appreciating the *beauty* of the great masters' harmonic writing would be excellent preparation. Not analysis, but mere attentive listening to the effects wrought by the masters

through harmony, the listening made as intelligent as possible by the incidental guidance of the instructor. Let the preparatory course be one in melody writing and in appreciation. Then in the harmony study, we can more successfully appeal to the music-sense. A basis for judgment of tonal effects shall have been attained.

Mr. Hawley: Melody-writing should be carried on simultaneously with harmony, else phrase-thinking is wellnigh impossible.

Mr. M. M. Rusch, Milwaukee, Wis: I agree with Mr. Hawley. Harmony is inherent in melody, and melody in harmony. To develop either independently of the other is to endanger genuine music-thinking. Of course, it is assumed that every student shall have had some experience in singing and hearing melodies before commencing the course.

Miss Campbell, Kansas State Normal School: Are we not in danger of becoming too technical?

Miss Alchin: No, what is worth doing at all is worth doing thoroughly. We are happiest in work that is thoughtfully and thoroughly done.

When shall the harmonization of melodies containing passing-notes be commenced?

Mr. Zanzig: As soon as the student is able to apprehend and intelligently use the primary triads in the harmonization of short chorales. After a long course in harmonizing every note of every melody, the student finds it almost impossible to harmonize melodies which demand other treatment.

Mr. Hawley: What we are all agreed upon is that the thorough bass system must go, and that harmonic study must be aural throughout. The rate of progress must depend on the development of the ear. In three years it should be possible to write from hearing, a four-part composition with altered chords and modulations; this, when three or four lessons each week are given.

Augustus D. Zanzig, *Secretary*, New York City.

ROUND TABLE NO. 6

Problems of the Normal School

C. A. Fullerton, Cedar Falls, Iowa, Chairman

The Normal School Section Meeting was held at the Hotel Pantlind, Thursday afternoon, March 22, with Mr. C. A. Fullerton, of Cedar Falls, Iowa, presiding. The "Preparation of the Grade Teacher" was the announced topic for consideration.

The inadequate time given to the training of the grade teacher by many schools led to a lively discussion by the representative supervisors present and some resolutions were adopted. A comparison was made of the courses offered in the various Normal Schools and Colleges as to the allotted time, requirements, and subject matter to be taught. The discussions follow:

Miss Root, St. Cloud, Minnesota: The report from the Carnegie Curricula gives but little thought to the subject of music; twelve weeks, five lessons per week, forty-five minute class periods, making a total of sixty lessons, forty-five hours.

Miss Ropes, Oshkosh, Wisconsin: The Oshkosh Normal offers for the primary and grammar grade teacher one semester of music (18 weeks) five recitations weekly, one hour each, also one semester of Musical Appreciation, one hour a week.

Mr. Archibald, Salem and Farmington, Massachusetts: The teachers' preparation for the first six grades is one period a week for eighty weeks.

Mr. Martin, Oxford, Ohio: The Teachers'College Course for Music Supervisors is for two years.

For the Grade teacher the first year elementary music, subject matter, twice a week, one hour recitation, throughout the year. The second year, methods, one lesson a week throughout the year. The sections are limited to twenty in number and graded in classes of musical und unmusical students. Five per cent of the students are monotones.

Query—Miss Foster: In the teaching of an art subject, is not much of the joy and spirit of the work sacrificed in placing the musically dull in one class, and the bright ones in another?

Mr. Fullerton, Cedar Falls, Iowa: A questionaire of mine shows five per cent or under are not musical.

Statement—Mr. Archibald: Public sentiment should be aroused against these students teaching music in the public schools.

A motion was made at this time and adopted, namely: That those who could not sing (monotones) should not be allowed to prepare as primary grade teachers.

Miss Amidon, Valley City, North Dakota: For regular grade teachers, six weeks, forty-five minute periods daily. For primary grade teachers twelve weeks, forty-five minute periods daily. A supervisors' course of two years.

Miss Smith, Winona, Minnesota: The grade teacher should not be discouraged for her failure in music reading and inability to teach the subject, but should be stimulated and encouraged.

Miss Foster, Ypsilanti, Michigan: For all teachers, Elements and Methods, two weekly recitation periods, fifty minutes each, of prepared work throughout the first year, total 72 recitation hours. For kindergarten and primary grade teachers, an added twelve weeks of primary music, daily recitations, fifty minute periods. All student teaching of music in the training school is done by those preparing as supervisors. A two and three year supervisors' course is offered.

Miss Strouse, Emporia, Kansas: One semester (18 weeks) two recitations a week. Teaching in the training school as an elective.

Statement—Miss Smith: California gives the grade teacher one hundred eightly hours of music.

Mr. Knapp, Mt. Pleasant, Michigan: Twelve weeks Elements, five recitation periods, fifty minutes each. Twelve weeks Methods, daily periods fifty minutes.

A discussion followed as to the amount of time that should be required in the training of the grade teacher:

Mr. Archibald: Two lessons of prepared work forty-five minute periods, with three recitations weekly throughout the two years.

Mr. Martin: Two class periods weekly, forty-five minutes, throughout the two years.

Mr. Fullerton: For all freshmen, not high school graduates, that Recreational Music be given for the third weekly period instead of physical training.

Mr. Archibald: Subject matter and sight singing should be taught the first year and method and practice the second year.

The following motions were carried:

1. That Elementary Music should be extended over a longer period of time, that two hours a week throughout the two years, 144 hours total, should be the minimum time required of high school graduates preparing to teach in the grades.

2. That a committee of three should be appointed by the chair to prepare a course of study for the grade teacher to be submitted for approval next year.

3. That the Normal Section, as a part of the Conference shall be a permanent organization and shall be so recognized as to sustain a permanent place on the regular Conference Program.

Clyde E. Foster, *Secretary*, Ypsilanti, Mich.

ROUND TABLE, NO. 7

Music Appreciation in the Grades

AGNES M. FRYBERGER, Minneapolis, Minnesota, Chairman

The conference began promptly at 2:15, when Mrs. Fryberger, presiding, laid the groundwork for discussion in the following pertinent statement:

"A most hopeful sign of regeneration in public school music is the fact that the real art lovers in the profession are securing a definite place in the course of study for teaching the appreciation of the subject. To borrow the unique expression of Dr. Winship, they are beginning to show 'appreciation of appreciation.'

Sad to record, there are many school children—perhaps the majority—who have had every minute of the music period throughout eight grades consumed in the pursuit of the technical. Sadder still is the fact that this pursuit has been associated with a few fuzzy, moss-grown text-books known to the board of education as the "series', and to the children throughout the color of the binding. The promised land, however, is in sight and the few clouds that hung in the sky have "turned inside out to show the silver lining."

A few minutes have been reserved in which a small per cent of those attending the annual Conference shall consider this important subject—the very essence of our professional existence. Let us use these minutes so well that we may demand in the future an entire general session to which every member must come, and when doors may be locked and power given to use the tyrannical method of Charlemagne—if need be—to baptize all into the new faith through compulsion. Music is dead unless it has intelligent understanding behind it, underneath it, all around it.

Fortunately, not one moment of our precious time is to be taken in considering the *why* of this subject. The *where* is already nominated: "in the grades." The *when* and the *how* are the issues.

Will you please discuss the earliest period in the school life when music appreciation may be introduced as a standard subject."

In a general discussion which followed, Miss Inskeep (Cedar Rapids, Iowa) stated that the child in the kindergarten should be taught to listen to definite things in music. It was generally agreed that listening lessons

should be systematically started in the first grade. The kinds of music to be used in the first three grades were considered with the conclusion that the following were needed: descriptive music for concentration, folk dances for rhythmic development, and simple artistic pieces for cultivation of taste.

The next point for discussion was "How shall the material be presented?" The session spontaneously developed into an experience meeting by Miss Inskeep telling how she had taught music appreciation through phonograph records before there was psychological thought given to the work. She closed her remarks by saying "this is an opportunity to question Mrs. Fryberger"—It became the will of the meeting that on account of musical experience shown in the development of "Listening Lessons in Music" the chairman be questioned as to a detailed method of handling the subject under varied conditions.

Mrs. Fryberger modestly replied to their questions telling how she began the work by going carefully through the general course of study and relating her subject as far as possible with all other subjects, at the same time noting the psychology underlying the method of presenting other studies. She gave concrete examples of testing out records in certain grades and of efforts to present her special subject by the same pedagogical methods used by progressive grade teachers in other subjects. Mrs. Fryberger also emphasized the need of teaching appreciation through songs in the text-books as well as by use of phonograph records, and in conclusion said "if greater discrimination were made by teachers and pupils between the good, mediocre, and the poor, songs in the average music text-books, there would be higher musicianship demanded in the compilation of such literature."

Mr. M. E. Chase (Malden, Mass.) raised the question as to how much time should be given in the grades for this subject.

Mr. C. H. Congdon spoke on the censorship of records and emphasized the importance of their careful selection.

Miss Worthington (Albion, Mich.) spoke of the marked improvement in late records and noted the fact that many recent and inexpensive records are of higher educational value than early red seal records.

Miss Inskeep emphasized the importance of the teacher's attitude in presenting the listening lesson.

Mrs. Elwood (Muskegon, Mich.) asked "How are the grade teachers fitted for carrying on the special lessons?" Which was answered by Mrs. Fryberger telling more from her experience.

It was moved by Miss Worthington, seconded by Mr. Congdon and unanimously carried that the subject of music appreciation be given a place on one of the general programs next year and that this motion be sent as a formal request to the program committee.

At 3:15 the conference adjourned through limitation of time. About fifty supervisors attended and were enthusiastic in declaring the inspiration and helpfulness of the meeting.

Ernest G. Hesser, *Secretary*, Bowling Green, Ohio.

Supervisors' Concert

Program of the Choral Concert by the Members of the Music Supervisors' National Conference. Directors: Father W. J. Finn, Mr. Harry H. Barnhart, at the Armory, Grand Rapids, Michigan, Thursday, March 22, 1917 at 8:30 P.M.

Program

Community Singing

Mr. Harry H. Barnhart, Director

Rochester, N. Y.

The songs will be selected from the following list:

The Star Spangled Banner	Drink To Me Only With Thine Eyes
Old Kentucky Home	Pilgrims' Chorus
Olk Black Joe	Send Out Thy Light
How Can I Leave Thee	Nearer My God To Thee
Nancy Lee	Lead Kindly Light
Annie Laurie	America, The Beautiful

Choruses by the Music Supervisors

Father W. J. Finn, Chicago, Ill., Director

1. Emitte Spiritum Tuum (Send Out Thy Spirit) . . *Schuetky*
2. In His Little Cradle . . . . *Franck*
3. And the Smoke Rose (from the Cantata "The Peace Pipe") . . . . *Converse*
4. Our God Will We Praise . . . . *Rachmaninof*
5. Deep River . . . . *Negro Spiritual*
6. The Sun Worshippers . . . . *Zuni Indian*
7. Unfold Ye Portals (from "Redemption") . . . . *Gounod*
8. Lullaby of Life . . . . *Leslie*
9. Weave In, My Hardy Life . . . . *van der Stucken*
10. Inflammatus (D. Mildred Heid, Soloist, Grand Rapids, Mich.) . . . . *Rossini*

Fifth Day, March 23rd.

FRIDAY MORNING

TOPIC: THE INTRODUCTION OF MUSIC INTO SCHOOLS WHICH AT PRESENT HAVE LITTLE OR NONE.

An orchestra of ten pieces from a rural district, of about 300 people, north of Grand Rapids, played a selection at the opening of the session. Only two of the members had had any instruction other than that received at the orchestra rehearsals. They had been working only since October. The instruction had been given by Mr. Leo Ruckle of Mr. Beattie's staff.

FRANK A. BEACH, Director of Music,
Kansas State Normal College, Emporia, Kans.

Mr. Beach: The topic for our consideration this morning is radically different from the subjects of our previous sessions. During the preceding days we have devoted our time to the various phases of our work and to our individual betterment. We have measured what we have seen or heard in terms of our own field. Today we are to devote two hours to problems which are primarily not our own. The consideration of how music may be introduced into communities other than ours is nevertheless in keeping with the spirit of public school music. From the first its sphere has been an everwidening one. Its beginnings eighty years ago were the outcome of a belief on the part of Lowell Mason that instead of studio instruction for the few, the community should give, through the school, musical training to all the boys and girls. Within the last decade Community Music has enlarged the school music field until it reaches the outmost bounds of the city. And now, the movement for musical extension opens a wide unoccupied region so great in extent that its very vastness is well nigh overwhelming.

As we think of the communities without music, there comes to our minds the small frame school house located at the country cross-roads, white when last painted, with its one room, caring for from five to twenty pupils; or we see a two-story brick building of six rooms which accommodates the High School and grades of a little town. Our train speeds past and we are impressed with the isolation of the place and thankful that our lot is cast in broader spaces. Compared with a city system like Grand Rapids the white school and the brick building seem insignificant. And they are. But of cities like Grand Rapids there are in the United States, some sixty; and of the small communities and hamlets 150,000 with a population ten times as great. A comparison of the several classes of communities based upon the census of 1910 is seen in Chart I. For our purpose these fall into two classes, the urban, A, B, and C and the rural D and E, the basis of division a population of 2500. To say that no music is taught in towns of less than 2500 would be far from correct. The relative proportion of the population in urban communities where music is taught to that of the rural communities where no music is taught is not

exaggerated, however, since in the decade ending in 1910 the population in the segments A, B, C increased thirty-four per cent as compared with an increase of eleven per cent in the segments D, E; and this disproportionate increase is undoubtedly much greater during the present decade. Further we find that the number of school children between the ages of six and twenty in the rural districts D and E exceeds the number in the urban districts by a much larger amount than does the total rural population exceed the total urban. This is made clear to the eye in Chart II. From diagram No. II we note that of every one hundred children attending school, forty are receiving supervised instruction in addition to the natural musical advantages of the city; the remaining sixty have the most meagre musical opportunities or more commonly are without music of any sort.

Why this paucity of music in the country? What prevents its beginnings and growth? The chief barriers to the introduction of music are the lack of interest,—a want of information—and an absence of equipped teachers. Interest is the chief essential; and this interest must be aroused from without. Rarely if ever, do we find anything like spontaneous combustion in matters educational and I believe never in what may be considered cultural luxuries. Someone must strike a flash from flint, touch the match or produce a spark by friction. In answer to a widespread inquiry the following means have been reported as effective in arousing interest in unmusical places: Community Singing; addresses at Teacher's Institutes and State Associations; demonstrations with the children in their own schools before Parent-Teacher's Associations; awakening the tax-payers through a demand from the interested school children; the modernized singing schools; women's clubs; the loaning of phonograph records and appreciation outfits. Sometimes rivalry plays its part. Two towns in Kansas are connected by what has long been claimed to be the best paying railroad in the world with its rolling stock of two discarded street cars and out of its round house there puffs every morning its tractor, one mule. Town No. 1 became jealous of a neighboring County High School which has made something of a splurge in music. Music was introduced in a small way with such evident results that the town at the other end of the line, previously impervious to all suggestion and argument, was spurred to action. Its Superintendent now avers that the expenditure for music is their best paying investment. High School music contests have aroused some towns where nothing else seemed effective. When music is earnestly desired its introduction is usually accomplished; and the opposition of one person or of an entire group is not sufficient to prevent. In Harvey County, School District No. 32 there lives a one-time lawyer and farmer by the name of Bolton who some years ago retired, (into his shell) and whose social life consists of a kind of perennial hybernation interrupted on groundhog days by taxpaying and casting a ballot with the opposition. When our esteemed friend learned that the district proposed to squander the large sum of $5 monthly for the introduction of music into the school he immediately threatened the supervisor with personal violence. Failing in his intimidation he took the matter into the courts, the plucky school board carried the suit through the Supreme Court at a cost of $250. This expense compelled the District to shorten the school year. But—music won.

Taking for granted the support of a teacher or principal, the final step is to obtain the approval of the governing board. This secured, we are confronted with the problem of adjusting the teaching force and curriculum in order to increase as little as possible the financial burden. A variety of plans for supervision and teaching are possible. By a combination of the grades and dividing the High School into two groups, schools with only one building have a so-called Supervisor who gives her entire time, meets her classes daily, at a monthly cost from $60 to $70. When the board includes a recalcitrant member he is ofen won over by combining music with one or more High School subjects. Almost any combination is possible—English, Modern Languages, History or Mathematics. Manual Training has been successfully taught by young men who are musically equipped. This opens a splendid field for boys familiar with band instruments and develops into stable citizens a group that at present lead a precarious and vagrant sort of existence. Supervision of two subjects such as drawing and music, physical training and music or penmenship and music meets the requirements of many small progressive communities. Successful studio teachers who have had sufficient training to acquire the method, and what is equally important, the viewpoint of school music, frequently make excellent supervisors; such teachers give three days to the school and the remainder to private work. Grade teachers who have methods and related courses once a week exchange work with the teachers of the other grades! The circuit plan of combining several schools conveniently located makes possible weekly visits with very satisfactory results. Sometimes the circuit includes both small towns and rural schools. In one county the supervisor formerly engaged in city supervision visits between thirty-five and forty schools in her Ford. In fine weather she is not a little envied by some city supervisors. For such service she is paid $5 per month. This is the result of six years effort and the hearty cooperation of the County Superintendent who says, "My life work will be finished when I can establish county supervision of music." This plan is advocated in several states but I have been unable to learn of its establishment. If brought about it would require more than a single supervisor to look after the seventy-five or one hundred schools. The talking machine has ardent advocates who maintain its value not only for the cultivation of musical taste but for the teaching of sight singing by the average teacher. I know a man who in addition to conducting a singing school for adults on modern lines six evenings a week, gives assistance to the rural schools of the communities and incidentally reaps a very substantial income. Supervisors who have had both rural and city experience assert that the eagerness of children in the country makes their progress much more rapid than that of children in the city. One enthusiast states they are seventy-five per cent better.

Having considered the Why? the What? and the How? of our problem there still remains the all-important—Who? Who will arouse the interest? WHO put into operation the plans determined upon? By measuring the interests and fitness of several possible groups we can discover an answer to our query. Legislators can pass no bills to arouse interest in music; community leaders and rural life experts mention the social value of music but more often than not do not employ it. Women's Clubs when

interested have not the savoir faire to carry the plan beyond the introductory singing stage. Music teachers' associations are chiefly occupied with extension in the cities and with the problems of the studio. State and County Superintendents can be relied upon only for co-operation at the most. Music Clubs are for the most part engrossed with programs and with their study. After this brief process of elimination we have left—the supervisor. The supervisors who have the enthusiasm, the knowledge, the material, everything but the necessary time. Various attitudes toward this problem as well as the progress in certain states is indicated by the following excerpts from letters.

MINNESOTA

"I am so busy trying to extend music into the souls and minds of the young ones in my own village that I have not kept in touch with the forces that are extending it into other places."

RHODE ISLAND

"This has been one of my dreams but thus far we have been unable to make it come true. As far as I know there is practically nothing being done for the extension of music into towns not now covered."

IOWA

"In my estimation the use of the talking machine in rural schools is beginning a new epoch. Several County Superintendents have purchased these to use with an outlined course and the results were almost magical. I speak on this subject almost every Saturday at teacher's meetings."

COLORADO

"At the Teacher's Institute I found a respectful and enthusiastic body of two hundred fifty rural teachers. I gave them my very best. I have since received frequent inquiries as to method and material and many favorable reports. One teacher announces the introduction of music as a regular study as a result of community singing."

MARYLAND

"Two years ago I installed music in three schools visiting them about once a month, this year I have oversight of six. The county hopes to train one of its own teachers as a supervisor. I met twenty-three County Superintendents and put in a plea for music. They have promised to push a talking machine course which I am outlining. This is gratis."

KENTUCKY

"The supervisors in our state have shown little initiative though there is now an awakening which may mean very much. Our Choral Club is sending a machine and records to the rural schools in a case made by the Manual Training Supervisor."

ARKANSAS

"I cannot give you help on the question as all my experience has been with schools where music has been well established."

OKLAHOMA

"The old fashioned singing school has done much here. Two-thirds

of the pupils who come to this Normal are products and they read well but sing sacred music as though the Almighty and His Angels were deaf."

ARIZONA

"Some of us grade teachers took the Victrola and gave a joint program of singing and records in a neighboring mining town where folks scarcely seemed to know what music was. Our own work keeps us very busy but we want to do all we can to spread the interest in music."

VIRGINIA

"As our resources are limited, I sometimes copy the words of the community songs and send out to interested schools."

LOUISIANA

"We certainly need the extension of music into the schools of our state but there is no one altruistic enough to undertake the burden outside of the city and our hands are full.

Does not this last compass the situation? We feel the need, the task is altruistic, but our hands are full. Must then the work remain undone? The program of the average supervisor is now so crowded that the addition of one thing more can scarcely overbalance the schedule. The world's work is done by the busiest people. But if we find the time what can we do? First, institutions and organizations should be interested in the definite work of musical extension with the ultimate aim of introducing music in the schools. Something in the nature of a Rural Music Bureau should be established—a clearing house for the plans and developments in the several states, with an active membership made up of those who are active in a real sense. But more specifically, what can we do as individual supervisors? First, correlate the work of some of our choice High School students with actual conditions in adjacent communities; second, through the local rural teachers or through the County Superintendent arrange for these young people to visit neighboring rural schools for the purpose (a) of giving a musical program, solos, duets, violin or cornet numbers, some talking machine programs, (b) community singing as a part of the proceeding or in connection with literary or other school programs. The high school print shop or typists from the commercial department may be enlisted to duplicate words for the community songs. Let each of these students take the teacher of a rural school for her musical charge, aid in the selection of rote song material and give suggestions for technical work when desired. All of this service will be gratis of course. This will be education that is worth while since it functions in life outside the school; encourages the young people to make some return to their state for their privilege of citizenship and education and counteracts the tendency to do things musical for credit, for applause or financial return. Third, offer your own services to the County Superintendent for an occasional monthly teacher's meeting. Lead in some community singing and give a talk on the subject of music in the rural schools and give suggestions as to how to organize and carry on this work. Fourth, set on foot a movement for County Supervision. Begin to train one or two of your students who are particularly adapted for supervision. Fifth, advise the County Farm Advisor of your readiness to furnish music and a leader for community sing-

ing at rural gatherings. Sixth, familiarize yourself with the records adapted for use with talking machines in rural schools including those bearing upon sight singing. Seventh, arrange with the chairman of the rural school section and with the music section of your State Teacher's Association for presenting at the next annual meeting, the subject of music for the country. Eighth, ,induce the graduates of music schools, conservatories and colleges who are dreaming about Chautauqua, Lyceum or grand opera, to add ballast and have a part in this propaganda. Ninth, utilize the club plan and if a state wide movement seems possible the Kansas Rural Music Club contains some suggestions that will be of value. Briefly, this has for its aim the promotion of music and incidentally drama in the rural districts. Any interested supervisor or music teacher who is willing to aid in the propaganda is made a member of the Executive Committee. His work is to arouse interest through community singing and musical programs and to recommend schools that are entitled to certificates. Of these there are three ranging in the requirements from community singing to regular work in music under a qualified teacher. These certificates bear the signature of Governor Capper as President, Superintendent Ross as Vice-President. The plan, only recently inaugurated has met with hearty response from music lovers, County Superintendents and wide awake rural teachers.

My study window affords two views, the first is toward the east; before me is my typewriter and desk with the reminders of the duties of the day, the busy street and beyond the campus. The other I did not discover for a long time so intent was I upon the first. It looks toward the west, there is a view that rests the eye and lifts the soul. Across the open field bordered with trees one looks to the brown of the blackbird marshes and then beyond to the rolling prairie with its endless promise of opportunity. Farther on and farther on it stretches until it loses itself in the horizon. It is the near view and the far view. The first is needful but I should become nearsighted in a double sense if I did not see the second. Is it not possible that the far view beyond our own immediate work is the very thing we need to motivate our own efforts and it may be to breathe life into the dry bones of a too familiar routine. The task is ours, not a burden for which we are responsible but a rare opportunity for service.

Paul E. Beck, State Supervisor of Music, Harrisburg, Pennsylvania: I wish that the purpose of my subject might be to tell you of the happiness I have in listening to the school choruses of a great commonwealth; of my optimistic good faith in the sincerity of my supervisors or of the promising outlook for the advance of public school music within my state.

But I may not do so. I am to speak instead upon the extension of music into schools which have little or none.

I have generally found no great difficulty in introducing a sound system of music training into such schools. Sometimes this is best accomplished through personal conference with the Board of Education. Such men have seldom looked into the matter of music study seriously and are often easily won to its enthusiastic support by a mere statement of its astonishing development within the common schools of today. Indeed, my most successful argument is frequently but an illuminating recital of musical activities as they are going forward in the schools of the immediate vicinity.

Another valuable and powerful means of widening the frontier of our realm is through the Parent-Teachers' Association. The active co-operation of this useful agency may almost always be enlisted by a sympathetic appeal to its appreciation of the great cultural value of music as a refining force. And here again, no argument is so potent as a straightforward narrative of facts.

The most serious problem, as I view it, is not the school district which has little or no music. The difficulty appears in the complaisance of such towns as flatter themselves that the loud and meaningless singing of their school children actually constitutes good music. In those misguided school rooms, after hearing a proud display of the raucous vocal noise, I am impelled to exclaim with the ill-fated Duke of Clarence,

"With that, methought a legion of foul fiends
Environed me and howled in mine ears
Such hideous cries that, with the very noise,
I trembling waked, and for a season after
Could not believe but that I was in hell,
Such terrible impression made my dream."

In these days one hears a great deal about Continuation Schools. Such schools are no longer an experiment. They have proved their intrinsic value and are accepted as useful units in the great mechanism of public education. Continuation School, as you know, simply means a subsequent continuation of school work. One of my highest ideals will reach its consummation when community singing, sincere and of high cultural excellence, shall have come to be but the natural continuation of the music of the public schools.

Such a condition prevails in the Pennsylvania city of Dunmore. The community singing which flourishes there is the direct outgrowth of the musical activities of the public schools. Had I but time to do so, I should like to tell you how the monthly "songfests,' as they are familiarly called, are conducted. Also how successful they are and what they have accomplished for the people.

Through these song meetings the parents and tax-payers of that city have come to be thoroughly posted upon what is going forward in music within their schools, and they fully appreciate the value of its influence upon the boys and girls of the community.

Thomas Whitney Surette, in a recent magazine article on Public School Music, says: "This complaisance of ours is no where more evident than in the large sums we spend on the teaching of music, and in our ignorance of the results. School boards and school superintendents usually possess little knowledge of the subject and have no means of knowing the quality and the effect of music-teaching save by such evidences as are supplied by the singing of the children at the end of the school year."

My hope, therefore, for the extension of music into such schools and such districts as at present have little or none of it, is that when the *people* shall know the truth, the truth shall make them free from incubus of that apathy in matters musical which now hampers the advance of their own cultural development.

President Dykema: I cannot refrain from making a remark about these articles of Mr. Thomas W. Surette in the Atlantic Monthly. We

must all acknowledge that Mr. Surette has done much excellent work in the articles. However woefully disappointing his treatment of public school music is, it is not my purpose to enter into a discussion of it. Mr. S's statements concerning public school music are based upon a ridiculously inadequate knowledge of music in this country. The actual opportunity was given him to know the facts as they really are. If the Atlantic Monthly had known the actual conditions they would have absolutely refused to publish these articles. It is very necessary that we know that they do not represent public school conditions in the United States. I trust you will pardon me in making so many remarks, but we cannot allow these statements to go unchallenged.

SOME REASONS WHY MUSIC SHOULD BE TAUGHT IN ALL PUBLIC SCHOOLS

S. S. Myers,

Director of Music Department, Kentucky State Normal School, Richmond

The president of a city Board of Education, addressing the teachers of the city assembled in a teachers' meeting recently, declared that the Public School exists only for the purpose of training the child to feed, clothe and shelter himself. "If anything more than this is taught," he said, "it is a waste of time." That man's educational ideas are based upon a philosophy too narrow and selfish to be given serious consideration; yet such school authorities as he, are a menace to the progress of the race. It is universally conceded that the function of the public school is to train for good citizenship as well as to develop the power to earn a living. That the process of education should consist in developing the best that is in the child—not merely the physical and intellectual parts of him, but the *child himself.*

As the intelligent, conscientious teacher stands before that bright-faced boy in the schoolroom he cannot help being impressed with the old saying that "Every child is a bundle of infinite possibilities." And, as he endeavors to study that boy, he realizes that his manner, his expression, his attitude, is not the boy. They may indicate something or nothing. Indeed he may use these very means to conceal himself from the teacher. Beneath all this is the boy himself. Deep down there in that inner life lie all the germs of power for good or evil—the wheat and the tares. The future must determine whether the wheat will bring forth a harvest, or whether the tares will spring up and choke out the wheat. What his future individuality will be depends somewhat, perhaps, upon hereditary impulse, but more—infinitely more, upon environment and the influences that come into his life.

If you were to go up into a bell tower and strike the bell one blow with a hammer you will have set in motion a vibratory wave which will pass outward in ever widening circles until lost on the distant air. But within the bell an entirely different set of vibrations will have been called into activity. First you will hear the pitch or tone of the bell, also another tone an octave higher; and, if you have a trained ear, you will hear still another tone an octave above that, together with the mass of overtones and related harmonies—a bewildering maze of harmony apparently

going higher and higher until it passes above and beyond the reach of your ear. But the fact is those vibrations will have gone neither up, nor out, nor down. They will have passed in, and in to the very centre of silence. So it is with every influence that comes into the life of the child—it goes in, and in until it reaches the child himself, and these it awakens and calls into activity some responsive power which, as it develops, goes toward the shaping of his individuality.

It must be conceded, therefore, that any influence that appeals to the best that is in the child is of educational value. And nothing does this so effectually as music. It lends itself to the expression of the purest emotions and noblest impulses, but it cannot be employed in expressing anger, hatred, envy and like evil emotions and passions because they do not respond to music and cannot thrive in a musical atmosphere.

Music is a language that begins where speech leaves off and leads on toward the ideal. There is a limit to written or spoken language—a point beyond which the poet or orator cannot go in attempting to give expression to the emotions of the soul; but music carries us on into a realm of self expression the borders of which literature can only touch. If all recorded history should be lost and forgotten we might still read the history of the human race in its music. The social, moral and intellectual life of a people, at any period, permeates its music.

The folk-songs of the various nations reflect the hopes, joys and ambitions of the human race at all stages of its development, while the works of the great tone masters give expression to the purest sentiment, the noblest aims and the highest aspirations of the greatest genius of the ages. All this is a wealth of inheritance which every child has a *right to demand* of those to whom is entrusted his training for the larger enjoyment of life.

Music is invaluable as a means of training for good citizenship. All children love to sing, and the song material provided for use in our public schools today touches all phases of human activity. Through the occupational songs the child gains high ideals of the duties and responsibilities of life in the work-a-day world about him. He may forget the things he learns from text books, but music gets into his life and stays there. The philosopher who said: "Let me write the songs of a nation and I care not who makes its laws," had a vision of the power of music in the life of a people

Songs relating to the seasons, to sunshine and rain, birds and flowers, fields and forests, mountains and streams, develop in the child a sense of the beautiful that can be comprehended only through the atmosphere of music. Thus he is brought in touch with the poetry of nature and his life is made broader, richer and happier. The Creator reveals Himself in the wayside flower, the glories of the sunset, the shadows of twilight, the starry heavens, the tints of the dawn and the splendor of the noonday; but these things can only be interpreted in the fullest measure through music.

All this relates to the cultural side of music; but, at the same time, it is an intensely practical subject. What would our churches and Sunday schools be without even the crude singing we sometimes find there? Wherever people congregate the need of music is felt. Whether the assemblage be for social, religious or political purposes, it unifies thought

and feeling, brings the people into closer touch with one another and gives inspiration to the meeting. It relieves the tension of the daily grind in the schoolroom, gives the pupils poise, control and power of attention that cannot otherwise be obtained and brings them into a happy attitude of concerted action.

The value of assembly singing, not only in the school room, but in the community at large, can hardly be overestimated. "It is difficult," says Gottschalk, "not to treat as a brother one whose voice has mingled with yours, and whose heart has been united with your own in a community of pure and joyful emotions." Every town, village and hamlet should have a choral society as a result of music teaching in the public schools.

There is no other study in the curriculum so conducive to health, not even excepting gymnastic exercises given in most schools. The deep and systematic breathing required in singing tends to develop the organs of respiration, strengthen the lungs and benefit the whole physical structure of the child.

The rhythmic element alone in music is of immense value in mental and physical training. Some time prior to the out-break of the European War an educational institution was founded near the city of Dresden, Germany, in which everything in the curriculum is taught to the rhythm of performed melodies. It is claimed by the founders that the physical and mental powers are thus brought to maintain an equilibrium giving equal poise to body and mind, and that through this condition the deepest recesses of the human being are called into harmonious activity. Without attempting to enter into a discussion of this idea I merely wish to state that it took educators a long time to grasp the possibilities underlying the fact that one who stammers miserably in speech can sing fluently and with perfect ease.

Music is now taught in the public schools of every city and town of any importance throughout the country where educators have come to realize its great educational value, and no longer mistake scholarship for education. Scholarship is a good thing, but Education is much more to be desired.

Scholarship is a trained intellect, Education is a trained human being.

Scholarship may measure the distance of the stars, calculate their weight and determine their courses through space. Education looks into the sky and sees beyond the stars.

Scholarship may interpret the dead languages and decipher the hieroglyphics of a forgotten past, but Education interprets the living present and builds for the future.

Scholarship has a tendency to isolate a man. Education brings him into sympathetic touch with the everyday affairs of life and enables him to look out upon the world and comprehend his relation to things in general and mankind in particular.

Music is not taught in the public school with a view to making musicians of the children, but that they may acquire through it a refinement of thought and feeling that will enable them to appreciate the higher ideals of life, which is so large a part of what constitutes real education.

The president of a school board once said to me: "We realize that

music ought to be taught in our schools, and that the children are being deprived of a great deal by not having it. But our teachers cannot teach it, and we have no money to pay a special teacher." This was an admission of a lack of knowledge on the part of that school board as to the real aim and object of child training. It was merely another way of saying that the things now being taught are so much more important than music that we can best afford to leave it out of the curriculum. The school authorities who realize the importance of music in the educational system, and who have the welfare of the children at heart, will provide means for having music taught in the schools.

I once heard a rural teacher say that she had so many things to teach and her daily program was so crowded that she had no time to teach music. Such a statement can only come from one who is ignorant of the value of music even as a means of recreation. It has been demonstrated beyond question that more work is accomplished in the schoolroom where a certain period, each day, is given to the study and practice of music, and the work is better done, than in that where music is excluded. It is like water to the thirsty plant. It recreates and stimulates to greater effort in other studies. When the children become weary, restless and inattentive in the daily grind of study and recitation, the music period relieves the tension of both teacher and pupils and puts new life into all the work of the day.

We occasionally find teachers who think they cannot learn to sing or teach music. But there is scarcely one in a thousand who cannot do both. Any one whose hearing and vocal orgas are not defective can learn to sing if he wills to do so. And one who can teach language or arithmetic can also learn to teach music. It is not essential that the teacher be an expert reader of music, or even a fine vocalist. We cannot all become great singers, but we can learn to read plain music, such as ordinary hymn tunes, at sight with some degree of fluency and teach the children to do so. If this is done it will make the work of the schoolroom more cheerful and the children happier, and it will also be doing much toward making the coming generation a people of high ideals, possessed of a broader sympathy and a loftier patriotism than is realized today. We, to whom has been entrusted the training of children for future citizenship, have a tremendous responsibility resting upon us. Our work must not be confined to the schoolroom only—we must reach out and, with voice and pen, ever strive to awaken school authorities and legislative bodies to a sense of their duty in order that the thousands of children who are still being deprived of all that music means in their lives while in school, and as future citizens, may no longer be defrauded of their rightful inheritance. If our vision is limited to dollars and cents—if we cannot look out upon the world, or into the future and see more than this, we will have missed our high calling. Let us, therefore, strive to inculcate that larger vision which will enable us to make the world a better and happier place in which to live.

Mr. Dykema: We are very glad now to have demonstrations of something we are vitally interested in. It is another indication of the fact that this Conference is bringing together many interests, and the reason we do this is because we want to ally ourselves with these things. We are very glad to give place on our program to two definite commercial

interests, which are putting forward the things we believe in. The two phases of work which will be demonstrated are the use of the Robert Foresman phonograph records in the rural schools and the records of the Victor Talking Machine Company. Children from rural schools near Grand Rapids will show what can be done in a short time. A representative of each of the two companies has during the past week, met these children and has assisted them in learning with these records something about music. It has been their aim to demonstrate what any capable teacher can accomplish in her own school without any additional supervision. These children are selected from a two or three room country school building, and so represent a considerably mixed group.

The various groups of children then entered. The first group had been taught not by a talking machine, but by a city teacher, Miss Mitts, who had visited the school one half hour each week, in this time giving lessons to a class of first, second, third and fourth grade children. This suggested one possible solution of the problem of teaching music in rural schools—namely, occasional visits by a supervisor from a nearby city.

The more novel method was that of using the talking machine in lieu of a trained music teacher. Robert Foresman had sent a teacher to this rural school for a week before the meeting of the Conference, and several lines of work with records which he has prepared for public school use, had been presented to the children. The lesson given before the Conference demonstrated a few of the excellent results which practice with these records might bring about.

The boys and girls were from a rural school where they had had little musical instruction. The class consisted of about thirty-five children, and all grades from third to eighth were represented. Previous to their demonstration Miss Margaret M. Streeter had given them five lessons, using the Foresman Educational Music Records in all her teaching.

Owing to the limited time allotted for the demonstration, ten or twelve minutes, Miss Streeter chose for illustration the following subjects:

1. Voice quality.
2. Rhythmic feeling.
3. Establishing key relationship. (Scale and chord track).
4. Feeling for chromatic progression 5-sharp 4-5.
5. Two part music illustrated by perfectly blended voices in simple two voice phrases.

Miss Streeter, being an experienced supervisor and realizing from her own experience that the only basis for musical growth is to establish true musical feeling for all problems, took that for the underlying principle both in the teaching and in the demonstration before the supervisors.

In accomplishing this result, certain records were selected. Those used for voice quality and key relationship present the scale and tonic chords sung with perfect intonation and voice quality. The children first listened to these beautiful models and immediately afterward imitated them, with the violin to guide and eliminate all possibility of mistakes. Since the records provide these same general patterns in the nine common keys, some of these studies might precede any music lesson. The study played would depend on the key of the melody to be sung from the regular text books. The notation of what is sung by the record and imitated by

the children is before their eyes in the book "Songs and Studies", used by the children. This association of sound and symbol is one of the most notable and valuable points in this method of instruction.

In the rhythmic work the children listened and then repeated various beautiful phrases in which are found all types of rhythm from the whole note to the dotted eighth and sixteenth, also all kinds of measures were used and compared, (2-4, 4-4, 3-4, 3-8, 6-8).

The chromatic problem (5-sharp 4-5) was illustrated in beautiful songs and rhythmic phrases which the children heard and imitated, thus building up a vocabulary of chromatic tone groups.

Harmonic feeling was stimulated by the illustration of two and three part songs and exercises in which the children heard the perfectly blended voices and followed the suggestion of the records in their own singing.

Miss Streeter said, "Realizing the limitation of many persons who are obliged to assist in the laying of foundations of musical growth in the children of the public schools, the greatest problem of the music supervisor is the unmusical efforts of the grade teacher to give the daily lesson. I have proven absolutely to my own satisfaction in my work with this and other classes, that Mr. Foresman's contribution to music in the schools of America is very great. This work, which dove-tails and correlates with any course of study or set of music books is invaluable to the musical as well as the unmusical teacher."

Another class of children was brought in and demonstrated the use of the Victor Talking Machine and its records prepared for public school music teaching, in the singing of beautiful songs which they had learned from the machine and in folk dances danced to the music especially selected for these dances. This work had been prepared in a two room country school, and the children showed their pleasure in the songs and dancing, even though the highly polished floor of the Pantlind Ball Room proved a very slippery footing.

The deep interest of the members of the Conference with the attempts to extend the use of music in the rural schools was evident from the beginning, and it was followed by a lively discussion.

Mr. Dykema: May I ask what was the reaction on the community by the installation of phonographs in the rural schools?

Mr. White of Des Moines, Ia.: May I answer that? We have two victrolas in practically every school which were installed by the Parent-Teacher Associations. These machines cost from $50 to $200, and the money was well invested for the results obtained have been immense. There are nine hundred children who have received the benefit of this system and they have been able to give demonstrations now and then. The people are very well satisfied with the results and are willing to use more of their money for this kind of instruction if it is needed.

Mr. Dykema: Let us have a report of the conditions in rural communities other than Des Moines!

From the floor: We have six victrolas in our county and we have just entered into the thing. As soon as the people see what wonderful results have been obtained they are very desirous to be of assistance in obtaining all the machines necessary. In some parts of the country there are more children in the rural schools than in the city schools, and though we have

been very successful in our district, this means that taking the situation as a whole, there are more children in this country that are not receiving this instruction than are.

Mr. Dykema: I think we all see that it is there that much has to be done. How are we going to get the phonographs and the proper records into the rural schools?

From the floor: I think one way of getting them into the schools is through the county institutes.

Mr. Dykema: Who else has some practical suggestions?

Mr. Fullerton: In one rural district the teachers and parents got together and purchased a machine. A social was held every Friday night, and a ten-minute program with the victrola was given besides other features. The school that gave the social was allowed to keep the victrola two weeks, at the end of which it was to be passed along to the next school. In this way the pupils were given the opportunity of improving their singing by the use of the victrola, if only for two weeks at a time. It also developed habits of frugality. I know that is being done in a great many schools. I believe the talking machine is most significant in extension work, and every normal and training school should have one. In not one of my meetings have I gotten along without a talking machine. We might as well try to get rid of Fords or Cadillacs.

Mr. Dykema: Has any one else suggestions to offer?

Miss Lucy Baker: Why not make the rural teacher want these phonographs?

Miss Amidon, Valley City, N. D.: In a rural district in North Dakota the women's clubs got together and gave an entertainment, the proceeds of which were used to buy a Victor machine. This was carried from school to school in the country and left in each school for a month. Every one felt a loss when the machine was taken out of the school. As soon as they were able ten or twelve country schools purchased their own victrolas, and would not now part with them. In Barnes County we have now twelve machines in the country schools. We go to these various schools and give talks on the Victrola and its uses.

Miss Strouse, Emporia, Kan: For the last six or seven years Mr. Beach has been sending out two machines and lectures with records. There are a number of schools in the state that have bought their own machines. During the time that the machines were so difficult to get, many thus had the benefit of one. A machine is sent to any community in the state or a rural school that wants one, provided it can get there in its little box by parcel post.

I was asked to go to a lecture and direct the singing that was scheduled. People for miles around came; it was a get-together club performance. At the close of the lecture the people sang for twenty minutes and were so enthused over it that they wanted more of it. I suggested that they have a gathering every so often but they objected, saying they could not sing without a leader. I told them a victrola would serve the purpose well. Victrolas are coming to be used more and more for instruction in singing.

BUSINESS MEETING, FRIDAY MORNING, MARCH 23, 1917

PRESIDENT PETER W. DYKEMA, Presiding

Mr. Dykema: Ladies and gentlemen, this is a continuation of the business meeting of yesterday. The first thing is the report of the Nominating Committee.

Report: President, Charles H. Miller, Lincoln, Nebraska; vice-president, Osbourne McConathy, Evanston, Ill.; secretary, Miss Ella Brownell, St. Johnsbury, Vermont; treasurer, James E. McIlroy, McKeesport, Pa. For the new member of the Board of Directors, Mr. John W. Beattie, Grand Rapids, Mich.

Mr. Dykema: What shall be done with this report?

Mr. W. A. White, Des Moines, Ia.: I move that this report be accepted as read.

Mr. J. W. Thompson, Joliet, Ill.: I second the motion.

Mr. Dykema: It is voted. Is there any further business in connection with this committee?

Mr. McConathy: I move that the chairman of the Committee on Publicity, Mr. Dykema, be appointed by this body for the next year to serve on the Executive Committee with the officers and Board of Directors.

Seconded and carried.

Mr. Dykema: We are now ready for the report of the Committee on Resolutions.

Mr. Gordon: May we first hear from the chairman of the Board of Directors regarding the place of meeting for next year?

Mr. McConathy: I wish to assure you that this is the most difficult work I have had in these five years as a member of this Board. We have never had so difficult a problem before us as selecting a place of meeting for the next year. We have given the most careful consideration and thought possible to it. Our report may not please you as a body, and I have no idea that it will please everyone of you, but I hope that you will realize the many difficulties that we have encountered. I trust you will approve of our final decision. We have decided to fix upon no one city at this time but to reserve the decision, contingent upon several conditions.

First, we propose going to Oakland, California, provided: first that the Chamber of Commerce of Oakland can secure for us a round trip rate from Chicago of $70; second, that the offer of the Chamber of Commerce to apply to the Chambers of Commerce throughout the United States for the financial assistance of Supervisors in going to the conference be considered only after consulting with the Board of Directors of the Association. Writing to another commercial body and trying to influence the School Board is a very difficult matter. So in our report we name Oakland, California, as our first choice.

Our second choice, provided these things do not happen, is Boston, provided that we receive an invitation to come to Boston from the Boston School Committee, from the Superintendent of Schools of Boston, from the Directors' Committee of the city of Boston, and from the Boston Music Commission. We purpose replying personally to every letter received from Boston. As a Board of Directors, we have received from thirty-eight to forty letters, including letters from the Governor of Massachusetts, the Mayor of Boston, from the Chamber of Commerce of Boston, etc., etc. We

purpose replying to these letters, saying that we thank these bodies for their kind invitations, but it has been our custom to go nowhere without an invitation from the school authorities, the School Committee, the Superintendent of Schools, the Director of Music, and the Music Commission, assuring us that they want us there.

If this second choice fails, we are most happy to go to Evansville, Indiana.

Mr. Dykema: We would welcome a discussion and suggestions from the floor at this time, but there are a great many factors which are not upon the surface which it will not be wise to discuss.

From the floor: One thing I believe we can do is to pass a vote of thanks for the very cautious and delicate way in which the committee has handled this matter.

Mr. Dykema: Let us have this suggestion in the form of a motion.

Mrs. Clark: I move that we accept the report of this committee with a vote of thanks. Seconded.

Mr. Dykema: It is voted.

Mr. Dykema: I wish at this time to appoint the committee asked for yesterday to work in co-operation to form one large committee.

From the floor: Mr. President, since this committee is the result of a very strong paper written and read by Mrs. Low, I wish at her request, to make a statement which will relieve the president from a certain embarrassment. Mrs. Low and myself both desire that the president appoint himself as a member of that committee. Hence I want to move that Mr. Dykema appoint himself as a member of this committee, as it is the opinion of this entire body. The motion was seconded and carried.

Mr. Dykema: I want to say that this is another of those kindnesses of which I have received so many during my term.

From the floor: Mr. Dykema, I want to express to you our appreciation of the work you have done.

Mr. Dykema: I had intended to appoint but four people on the committee of this Association. There are already on the committee of ten at least six or seven who are active members of this Association. The new names which I shall add, numbering five, since mine is to be included are: Mr. Glenn H. Woods, Oakland, Cal.; Mr. T. P. Giddings, Minneapolis, Minn.; Miss Eunice Ensor, Detroit, Mich.; Miss Jeanie Craig, Macon, Georgia; Mr. P. W. Dykema, Madison, Wisconsin; these will swell the committee to a total membership of 15.*

Mr. Dykema: It is necessary for me to appoint at the conclusion of the treasurer's report an auditor. We will now hear the treasurer's report.

Report by Mr. McIlroy.

Mr. Dykema: I will appoint as an auditor on that Mr. Will Earhart.

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* The other ten members of the committee are Mr. A. J. Gantvoort, Cincinnati, Ohio, chairman; Mr. Frank R. Rix, New York City; Mr. Hollis E. Dann, Ithaca, N. Y.; Mrs. Frances E. Clark, Camden, New Jersey; Mr. Charles H. Farnsworth, New York City; Mrs. Henrietta Baker Low, New York City; Miss Frances Duetting, New York City; Mr. Will Earhart, Pittsburgh, Pa.; Mr. Edgar B. Gordon, Winfield, Kansas; Mr. F. A. Beach, Emporia, Kansas.

We have heard this report which means that in all probability we shall have a good balance on hand when all funds are in.

Mr. A. W. Mason: I do not know whether it is the oversight of the Board of Directors or whom else, but we have not done our duty in one matter. Last year this body decided that it would be but fair and proper that the treasurer should receive some financial recognition, for the time, labor, and thought that was devoted to this office. We have not done it. I certainly feel that we are amiss in our appreciation of the work of Mr. McIlroy. Just who is at fault, I do not know. Therefore, Mr. President, I move that the new Board of Directors be authorized to consider the matter of appropriately recognizing Mr. McIlroy's work. This is a matter of neglect and I feel that it should not run on any further than this. The motion was seconded.

Mr. Dykema: Past records show that Mr. McIlroy has already received the sum of $50 as a compensation for his services last year. You will find on page 127 that the treasurer, by action of the conference, received $50.

From the floor: I move that Mr. McIlroy receive $50 for his work this year.

The motion was seconded and voted.

Mr. Dykema: Before the committee on Resolutions makes its report, I should like to introduce to you our incoming President, Mr. Charles H. Miller.

Mr. Miller: I think that I have received all the honor that it is possible for anyone to receive from a National Conference. It is such an honor that any supervisor could not be justified in declining it. I want to thank you for all the kind things that have been said by so many of you that will be of help in carrying on the work of preparing for the next conference. I have already solicited and received the promise of the other officials that we shall have perfect co-operation.

Mr. Dykema: I wanted to put it to the conference to decide whether some of these Round Tables which have been started should continue through the year. If the findings of the Round Table are of sufficient value, shall they be published? Prof. Cragun is a very able person in the matter of music survey. He has worked out some very definite things in certain directions. We are very desirous that the matter of deciding what measurements should be applied to the music situation, should be formulated in the work. It was suggested that Prof. Cragun be Chairman of this committee and that Mr. Withers of St. Louis and Mr. Earhart of Pittsburgh be appointed members of that committee. I think it would be desirable to take up this whole matter of appointing permanent committees to work on this Round Table.

Mr. Miller: I move that the Executive Committee take in hand the matter of appointing permanent committees to work on the Round Tables.

The motion was seconded and carried.

Mr. Gordon, Chairman of the Committee on Resolutions, submitted his report and it was accepted as read.

REPORT OF COMMITTEE ON RESOLUTIONS

Be it resolved, that we express our most earnest thanks and heartfelt appreciation to those individuals and organizations who have contributed so largely to the success of this, the Tenth Annual Session of the Music Supervisors' National Conference.

In particular do we recognize the courteous co-operation of the Superintendent of Schools, Mr. W. A. Greeson, our host, Mr. John W. Beattie, and his efficient co-workers.

Contributing in no small degree to the success of the Conference has been the substantial assistance rendered by the Common Council, the Association of Commerce, and the Teachers' Club of Grand Rapids.

Special thanks is due the Herrick Piano Co. for the use of the Concert Grand Piano, Mr. C. C. Birchard for song material, and Paul Weaver for his services as accompanist.

The deepest inspiration and the impression which will remain longest with all of us was the spirit of song, brought to us by Father W. J. Finn, of Chicago.

Of inestimable value in shaping the destinies of the Conference has been the personality, the high ideals, and broad purposes of our President, Peter W. Dykema. His rare vision of service and his willingness to give of himself so freely cannot fail to enrich and ennoble all who come under his influence.

Respectfully submitted,
Edgar B. Gordon,
Agnes E. M. Fryberger,
Hollis E. Dann.

The first draft of the telegram to be sent to President Wilson was read.

Mr. Dykema: Let us just say who we are and whom we deal with, rather than informing the people how great we are. I do not know whether this appeals to you or not, but I think that we might better say that we are Music Supervisors, largely in control of the music, not only of the children, but of the people of the whole country, and we are happy to use whatever influence we have. Mr. McConathy, may we have your opinion on this matter?

Mr. McConathy: The point that you raised is one that I had not thought of. I think that your point is well taken that we are exalting ourselves, although we are a powerful influence in teaching patriotic songs. If there is any possibility of its being misconstrued as such, the telegram should be corrected. Therefore I move that the telegram be altered.

Mr. F. A. Beach of Emporia: I second it.

Mr. Dykema: The resolution is carried. As it is very late now, and I know that you are all very anxious to have luncheon, it is moved and seconded by the whole company that we adjourn. You are adjourned.

Friday Afternoon

How to Cause the general interests of the community to develop into Permanent Art Manifestations.

MR. HARRY H. BARNHART, Rochester, N. Y.

As I understand I am to talk to you about community music, I will endeavor to relate to you several of the instances that have occurred to me in the past. For a great many years I have noticed activities going along. Thus unmolested, we have been giving the people community music. You get an artist to go and sing to a group of people, and you will notice that the development of the group is very encouraging, in a few weeks. And I have noticed another method, having groups of people in different parts of the city studying music. Community singing can be taught in different ways. Take a group of musicians on the violin and other orchestral instruments in the room, and have them play. All these things have been done, and just how right or just how wrong they are, I do not know. I believe some of the best people in the country have developed themselves to play and sing well through this community work. I have gone many times to conduct different singers. I see it is a good thing, and I expect that work to go along, being developed in the schools and other places. I see the natural singing in a different way. I look not upon the community choruses as a little group in this part of New York only, but as representing New York, Rochester, Grand Rapids, and other places, and I look upon that as a part of our nation.

I find that our people in a group never sing out of tune, never sing rag time. I could never get a crowd of this kind to sing bad music. Now, these are fundamental facts. A crowd of people singing in a group is not community singing. That does not give you the heart of it. Community choruses and community singing must express that thing, that fundamental quality for which we are all striving as a people. Community choruses, therefore, are one of the highest expressions of music that there is.

Take a crowd of people in a hall or any other place holding 1000 or 1500 people, put the music in their hands, and in a few minutes they will be doing unaccompanied work. And in ten rehearsals, ten consecutive meetings, you have a concert program prepared, such as you have been unable to buy in any town. You must have the community desire it. You cannot give the community anything unless they reach out for it. Wanting it, in ten weeks they are able to give you a concert. You do not believe this, but when it actually exists, and they give you all the art quality, it is a fact which you cannot but understand. Any group will do that much now, if the community is willing.

Why not accept that and go still farther? Why not include all the working people? We have not found our true brotherly relation as people and I am working to bring this about. Generally we find community singing helps in this way. It brings out all the harmony of your soul.

Look at the music of our usual programs. Only two per cent of our

nation are in it. The other 98 per cent hang their heads and if we are to reach them—it is pretty nearly time we were reaching them—it must be with a million different concerts every year for their benefit.

Ten years ago I said ninety per cent of grand opera was a failure in the market. I know grand opera; I can sing it. I lived in Italy and have been in some of these places where grand opera comes from, and I can understand it.

If we are going to get down to the permanent thing, to brotherhood, we must look to music. Music has never failed any nation yet. So take all the arts together. And out of that you will have new theatres, etc. You can see it coming in the distance. You can see it coming here, there, and everywhere. I look upon community singing as a fundamental spiritual power of our nation.

Frances F. Brundage, Superintendent, Civic Music Association of Chicago: It is not easy to add a "postscript" to a week of experiences so varied and stimulating as these of the Supervisors' Conference,—one allotted "fifteen minutes" has changed color several times each day according to the light played upon it by the other speakers.

In the matter of Community Singing we all seem well enough agreed that our failure to produce a national music in America is due to our concentration upon the talent and psychology of the individual to the utter neglect of the composite genius of the people.

In the recent movement to correct this condition, we have at best a selfconscious effort to revive what was originally a spontaneous expression, and there is small wonder that we differ in opinion as to method of procedure,—as to what seed shall be sown in this "replanting" and how it shall be nurtured.

To expect the participation of people in community singing to develop an art form is to fore-see a people musically alert and equipped. To provoke this interest, to return to mass consciousness the working elements of the musical art and then to trust it to its own destiny is about all that we can do.

Since the taste of people and little children may always be trusted when they are given the opportunity to experience the true and the beautiful, it would seem our responsibility to make abundant provision for this opportunity and our problem to choose the right material.

The Folk Song in its simple perfection answers the need for material, —it is at once the product of the people and the key to the great musical literature, since every true composer has acknowledged his indebtedness to the genius of the people by glorifying their spontaneous song in his universal masterpiece.

Clearly a people seeking its artistic expression must use all the elements of that art, if we can be said to "return music to the people" we must return the whole music and not be fearful of returning knowledge with the spiritual and emotional enthusiasm. Nor does knowledge mean that "dry-as dust" thing on paper that we are learning to distrust, but rather something akin to the "overpowering vision" as Wagner described his first realization of the meaning and relation of the three tones of the tonic triad.

Again the Folk Song offers the perfectly balanced elements,—heart, soul and mind—simple enough for us all.

Larger forms under an inspired leader may lift people to great emotional heights, but the question is whether they may in turn seize upon the form for independent use. Is there not always a dependence upon numbers and a leader?

It is certainly true that we cannot turn back from our complex life to the primitive existence of the "Folk", and that we must find the mode best suited to our modern life. On the other hand, the present chaotic, one might almost say hectic, condition of life and art might seem less hopeless could we return to elemental simplicity long enough to understand ourselves and each other. It is from some such basis of understanding that we must work, faithful to our "stewardship",, trusting to people and beautiful songs and believing that "All America will sing!"

George Colburn, Director of Municipal Music, Winona, Minnesota: Considering the many comprehensive papers on this and closely related subjects, given so effectively at this Conference, I believe a brief description of actual activities along this line will prove of interest.

A little over two years ago a group of men incorporated as the Winona Municipal Band Association, with the provision that orchestral and choral work be fostered when desirable. A fund to last three years was raised from four sources: Popular subscription, three-year guarantees, City Council and the Chamber of Commerce. The President of this Association and I exchanged views on this venture and as a consequence I was engaged to carry out the work in the following way: Two Bands were organized, one a beginners' band of 25 members, the other a professional organization of 35, for the purpose of giving free summer concerts, and supplying music at fairs, political meetings, patriotic gatherings and all municipal activities. This organization gave the subscribers tangible results for their contributions. I began rehearsals in June and by August was able to give some very acceptable concerts. Each division had three rehearsals a week. In the Fall, a suite of rooms was engaged for our sole use and a male chorus of 30 was assembled. This organization made its first appearance with the band in Mendelssohn's "Sons of Art" and scored a success. The band during the winter developed remarkably, members increased to 45 men, and the tone quality was dignified by the addition of oboe, bassoon and saxophones.

We used various devices in the winter concerts to make people willing to pay admission, after a series of free concerts. A notable success was the Promenade Concert at the Armory where the audience was permitted to sit at ease around tables and partake of light refreshments, if desired. Some talented singers of the city drew well and the appearance of the Men's Chorus was sure to bring response. A feature of the winter's activities was the Municipal Christmas Tree celebration; seven Christmas songs were selected and rehearsed with choruses from the Churches. I made suitable band accompaniments and prepared a Christmas Overture. The band was placed in a big tent open on one side with two red hot salamanders in the back to keep the instruments from freezing. During the second summer the professional band gave a series of free concerts and

the beginners' band made some creditable appearances. The second winter found the activities broadened to include strings. I organized two branches here—a student and a professional division—the season was marked by the successful substitution of three string basses and two cellos to the band ensemble. Two of the concerts are worthy of note, The Community Song Concert where the program was interspersed with enthusiastic singing from the audience, and another concert where an experiment in adding violins to the band was tried out. This was done by transposing the clarinet parts though full chord, tremolo and pizzicatti effects were not ignored. The junior violinists also appeared in two unison numbers accompanied by an orchestral combination from the band. I hope to include folk dancing, pageantry, choral and operatic efforts with the work already done, this following winter. I do not engage in private teaching, keeping out of all alliances that would make co-operation of the various conflicting musical interests of the city, difficult. We try to make the most of the material at hand, depending upon what talent the city can offer. It is a problem to supply a musical background for our performers and when possible we get skilled artists who may be traveling through with operatic or other organizations, to speak on the care of instruments, points in technique and phrasing, as relating to oboe, bassoon, French horns and other difficult instruments. I have recently made arrangements to use a phonograph in band rehearsals and will talk on points of interpretation of, for instance, the overture to be rehearsed. The beginners' band has graduated 15 useful members to the professional division which now numbers 50. This rather sketchy record of the past few years' work is influenced in content by many questions and letters received regarding my work, and may help others in formulating policies which will, of course, vary with conditions.

Mr. Barnhart: Many of you people here, and in other places think that I started in a large city. I obtained my start in the little town of Wyoming, New York, and I can show you programs where we had 125 people out of a population of 500 who came regularly to the meetings every week. And a chorus of 125 people can make some singing.

I loved this work and worked right along in a dozen such communities, and I was having the time of my life when they came from New York, and dug me out, and made me go on the road.

Now, people, you must keep a large portion of the spirit, of the soul. When you are called to bigger demands, go ahead.

In the country there are no choruses large enough to do any real things. But we must point forward to the highest, and not try to meet them on a mediocre basis for anything. And so it will go, lead them high. And it can be done in any community.

Ques.: How many of the notes do they get?

Ans.: They got all of the notes, if you please, sir.

But many of these people never saw much music before; they came from eight different communities. We would call it a community singfest. Then I engaged a real symphony orchestra. They had never rehearsed with an orchestra. A great many people never saw that many fiddles and horns, and one woman asked what that horn was that went round and then out like this. (Illustrating with arm.) Of course it was the French horn.

The evening before they sang Mendelssohn with a chorus of only 500. That afternoon they sang Rosinni's Stabat Mater and they sang it well, but in the afternoon it was only a rehearsal. In the evening I saw people with tears running down their cheeks, when the tenors held that high G.

Ques.: Does it take long to work a group of people into a chorus?

Ans.: I would begin at once. The first music, which sells for 5c a copy, consists of eighteen little community songs. It is first rate, and the low price enables every person to buy a song book. (Mr. Dykema: This collection of eighteen songs which he speaks of was selected and published by this association.) (Mr. Barnhart, resuming.) Good, I am glad to know it. In your new book I see you have the Pilgrims' Chorus and also "Send Out Thy Light." I have them sing the "Pilgrims' Chorus", and I wish you could hear it.

Ques. How do the people read music?

Ans.: We must take music as a psychology. Melody, rhythm and harmony are inseparable. We cannot get a material analysis of these things. Once you get a crowd loosened up a bit, it is not difficult to develop the spirit of it. You get the basses in a group, and then the tenors, and get these respective parts started, and you will get a general idea of how music is read. Now, you would be surprised, how in a general sense, everybody can read music.

I have a letter from a large city, saying: I would like to know how to get people to read music. But I have already told you. We divide them into classes, and before long we have them in the choral society. All this comes natural. It is as natural as it is for water to flow down hill. Of course you must help them. You must have patience. We sing almost without our notes. I sometimes have a separate room for reading music, and I have tried taking sometimes, as long as 20 or 30 minutes for this reading outside. I sometimes teach music, but only for fun. I wish we had enough teachers and instructors to do that. I hope I have shown you something to give you help in the reading of music.

Mr. Birchard, Ques.: Do you have difficulty in dividing them into separate parts?

Ans.: As a rule we do not have much difficulty in dividing them into parts.

Ques.: Do you have enough musicians to take all parts together?

Ans.: Certainly, when I give them a new piece, they will go home, practice it over several times on the piano, and come to the next meeting all ready to sing it. I especially noticed this to be true at last Christmas time. I teach them the book from cover to cover, and I don't tell them how bad they are. Never mention the bad part of it. I found them grouped together about the piano in several instances. It is a very wonderful thing to get a musicale like that. We could not do these wonderful things with the community choruses, if it were not for the teaching of music in the schools.

Ques.: Do the people without musical training, find it very hard to learn?

Ans.: I don't think so. You take an ordinary crowd of people who have not graduated from the high school, and although they are slower in progressing, they can be taught. The average person in a large city

has never heard "The Heavens are Telling". At a large convention last year, I asked the crowd how many had never heard it. There were 80% of that crowd who had never heard it. In rural districts it will drop down to less than 50%, and in some places to only 20%. They are, in several instances, very willing to learn. They start it themselves. They run it themselves. I have never seen it equaled in any place.

Ques.: How much emphasis is placed on the importance of the words?

Ans.: Very much emphasis. Do not sing unimportant words. Not that mushy stuff. It must be universal. It is a very important thing. Keep it high and noble and never give up singing such songs as Old Black Joe. Don't think you can transplant these old folk songs. You cannot do it. I have tried it repeatedly, and I have found it could not be done. Among a group of Italians, only 6% of which could speak English, I once asked what they wanted to sing, and they promptly replied, "Olda Blacka Joe."

Ques.: Is there no organization for such work?

Ans.: Yes, they have a president, a vice president, treasurer, and secretary. In a city like Grand Rapids you should have five or six vice presidents, and you would solve the problem. They should have that new Armory practically filled once a week for this singing, and some of the most beautiful singing Grand Rapids has ever heard would be produced.

At the conclusion of the discussion on the above topic, the chairman recognized Mr. McConathy.

Mr. McConathy: Our President in the warmth of argument this morning made some statements about some articles which appeared in the Atlantic Monthly. These remarks aroused considerable discussion. As a result I have been asked to bring up the question: "Shall these remarks be made the official statement of the Conference, or shall they be allowed to stand as they were given, as the remarks of the President?" As I recall these statements they were as follows: "We are in possession of the facts that show first, that Mr. Surette's survey of public school music was not based on a knowledge of the general situation of the country. Secondly, that he had failed to take advantage of the definite offers made to him, to acquaint him with the public school interests." Nothing that Mr. Dykema has said over-states my feelings. I regret what Mr. S. has done and is doing to injure the cause of public school music. But I question the wisdom of this step of officially promulgating the statement Mr. Dykema has made. In no sense because I disagree with his statement, but only because I do not yet see wherein it will improve conditions. I do not see wherein our protest has a constructive possibility. I think our constructive work is the thing we must all look forward to. Now if it is possible for us to put forward any statement, wherein some point will be given to be of some value to us to do something, I would be heartily in favor of taking such action. At present my only question is a query as to how that statement can be made constructive and helpful.

Mr. Giddings: This is the side that appeals to me. I agree with our President's remarks and think that they should be made the official expression of the Conference. I would like to state two facts. Those articles were not satisfactory, evidently, to a large number of people. We have a system of music in the schools which Mr. Surette seems not to be aware

of. I have seen the effects of his work on the Boston schools in the near past. It affects all of us. Whatever Boston does has more or less weight with the rest of the country. Several groups get discouraged and say that our work is of no consequence. And I say that we should utter a very firm protest. We ought to place ourselves on record, so that the people of the country could have that to run up against in some way. Because after seeing how it has worked out, it is simply not to be tolerated. The whole question is as to the wisdom of his articles and the tendency which they represent. I should like to move that his remarks made this morning be accepted by us.

Mr. Dykema: One of our visitors told me that he was surprised to see how the Conference proceeded without any trouble. He said as soon as any trouble started, the one who started the trouble dismissed the subject and the trouble was over. I was just a bit afraid that some of you were over-concerned with what Mr. Giddings said. I am sorry that there are so few people who are willing to say that they are wrong. Would this thing meet the approval of our Organization? Let us send a note or an article to the Atlantic Monthly, asking them to publish it, as we have a right to be heard on this subject. And if they do not do this, it will be remitted to the United Press and the whole country will hear it.

Mr. Earhart: I am well acquainted with the Atlantic Monthly. I do not think a protest, even a just protest, will do any good, for while it may be convinced to some extent, it cannot be altogether dissuaded.

Mr. Dykema: The remarks I made this morning were made on the spur of the moment. They were given as a personal expression, because our good friend, Mr. Beck had in mind some of the fine points of Mr. S's article. Now, many people reading those articles will say, if some of them are good, they probably all are. The general public has a right to know what school music is or what is ought to be. I think this is the one organization in the country that has the right to answer his article. I suggest that a committee be appointed to frame up a definite answer to Mr. S's article.

Mr. Earhart: I am well acquainted with Mr. Surette and have heard from his own lips, something like two years ago, practically all that he has written concerning public school music. The Atlantic Monthly has to be convinced that we are right and he was wrong. I consider Mr. S. as a personal friend. There is a lot more I know personally. I want in some way, to overcome the evil influence of Mr. Surette upon public school music. Mr. S. is a brilliant thinker, and I believe that when it comes to presenting the thing on paper, Mr. S. will get the verdict, whether right or wrong, from the people. Study his articles, and you can find out whether I am wrong or not.

Motion made, seconded, and carried that a committee of three consisting of Mr. Earhart, Mr. Giddings, and Mr. Beach investigate the entire situation of the effect of the Surette articles, decide what is needed to be done regarding them, and then take such action (or lack of action) as they think best.

The Conference adjourned at 3:45 P. M.

The following telegram, formulated by the Committee on Resolutions, was sent to President Woodrow Wilson:

March 23, 1917.
To the President of the United States,
Washington, D. C.

The Music Supervisors' National Conference in session at Grand Rapids, Michigan, representing a profession that selects the songs and directs the singing of twenty million children and in increasing degree of the adults of the nation, send their hearty greetings. We pledge our loyalty in this trying hour and will endeavor to wisely direct this powerful influence for inspiring patriotism through song. We desire to express our confidence in your guiding hand, knowing full well you have at heart the welfare of our nation and will ably direct its course.

Peter W. Dykema, *President*.

The following reply was received under date of March 25:

The White House
Washington.

The President thanks you cordially for the good will which prompted your kind message, which has helped to reassure him and keep him in heart.

Treasurer's Report

JAMES McILROY, McKeesport, Pa., May 25, 1917.

1917	EXPENDITURES	
Feb.	1—F. C. Blied Printing Co., (Printing book, postage)...$	396.30
March	2—Torsch & Franz Badge Co., (Buttons) Baltimore, Md..	16.18
Feb.	26—W. T. Forrester Co., (Index outfit) McKeesport, Pa...	4.20
Feb.	12—Dennison Manufacturing Co., (Tags, etc.)...........	2.09
March	22—Express and postage to date........................	8.20
March	13—Hutchinson and Broadbent—Printing receipt books and cards—McKeesport, Pa.	13.00
March	13—Central Michigan Paper Co., Paper................	1.22
March	13—John W. Beattie, telegrams, etc.	13.00
March	23—Mailing books sold, etc., to date......................	5.12
March	23—White Printing Co., Programs........................	21.50
May	5—R. H. Stetson, Oberlin, O.	23.71
May	5—Father W. J. Finn, Chicago, Ill.	100.00
May	5—Harry H. Barnhart, Rochester, N. Y.	30.50
May	5—P. W. Dykema, Madison, Wis., Secretarial expenses, Grand Rapids meeting	38.70
May	5—Supt. J. H. Francis, Columbus, Ohio................	36.25
May	5—Percival Chubb, St. Louis, Mo.	100.00
May	5—Dayton C. Miller, Cleveland, Ohio..................	26.40
May	5—John W. Beattie (Account of Fuller Sisters)..........	50.00
May	5—Tracy Music Library (Rental)......................	3.75
May	5—C. C. Birchard & Co., (Rental)......................	5.00
May	5—Nelson E. Hubel, Reporting........................	10.00
May	5—Fred W. Zinzer, Reporting..........................	10.00
March	23—Western Union Telegraph Co., (To President Wilson)..	.90
March	23—James McIlroy, Jr., (Honorarium by action of Conference)	50.00
March	23—Banquet guarantee deficit	8.00
May	25—Postage etc., March 23 to May 25..................	4.16
	....	1.20
May	28—Alice McMullen, Typewriting List of Names........	2.50
		$ 981.96

1916	INCOME		
July	15—Cash on Hand		$ 264.41
1917	Membership dues—		
May	25—289 Active, new	$722.50	
	209 Active, renewal	313.50	
	110 Associate	110.00	
			1,146.00
	Proceeds of Chubb lecture	35.00	35.00
May	25—Sale of Books (62 at $1)		62.00
			1,507.41
	Expenditures		981.96
	Cash on Hand		525.45

Pittsburgh, Pa., May 29, 1917.

I have this day examined the above Treasurer's report and find it correct.

WILL EARHART, *Auditor.*

Richards, Hazel .... Grand Rapids, Mich.
Riemann, G. Fred .... Camden, N. J.
Rowel, Celene .... Grand Rapids, Mich.
Rowe, Helen Mary .... Grand Rapids, Mich.
Rowe, Mrs. Wm. S. .... Grand Rapids, Mich.

Saurer, Harold D. .... Chicago, Ill.
Sheehan, Catherine .... Grand Rapids, Mich.
Showers, Frank .... Muskegon, Mich.
Sichler, Agnes E. .... Alma Center, Wis.
Sigler, Mrs. Lou R. .... Grand Rapids, Mich.
Smith, C. W. .... Grand Rapids, Mich.
Smith, Mrs. C. W. .... Grand Rapids, Mich.
Smith, Mabel W. .... Holland, Mich.
Smith, Wilhelmina .... Chicago, Ill.

Thole, Elsie .... Grand Rapids, Mich.
Thomas, Mother Mary .... Grand Rapids, Mich.
Travis, Mrs. Calla .... Grand Rapids, Mich.

Uhl, Irma .... Charlotte, Mich.

Van Brook, Edith .... Kalamazoo, Mich.

West, O. P. .... St. Louis, Mo.
Wherry, Mrs. John T. .... Wyoming, Iowa.
White, Mrs. W. A. .... Des Moines, Iowa.
Wiedenbeck, Emilie .... Madison, Wis.
Williams, Alden .... Grand Rapids, Mich.
Willman, Madeline L. .... Madison, Wis.
Winkler, Mrs. Theo. .... Sheboygan, Wis.
Withey, Leroy G. .... Grand Rapids, Mich.
Withey, Mrs. L. G. .... Grand Rapids, Mich.
Worden, Lucile .... Kalamazoo, Mich.
Wright, Lucile J. .... Holland, Mich.

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1914: MINNEAPOLIS

Appreciation of Appreciation, address by Dr. A. E. Winship.
Efficiency in Music Teaching, papers by Francis Wright, Ralph Baldwin and C. A. Fullerton.
The Value of the Beautiful, address by Charles H. Farnsworth.
The Place of Music in the Reorganization of Secondary Education, paper by Will Earhart with discussions by a large number of supervisors.
The Appreciation of Music in the Grades, paper by Miss Mary Conway, and discussions by a large number of supervisors.
The Training of a Singer, address by D. A. Clippinger.
Community Music: Report of the committee.
The Use of Pictures in Teaching of Music, paper by Estelle Carpenter.

1915: PITTSBURGH

The Relation of Rhythmic Exercises to Music in the Education of the Future, address by Earl Barnes.
Music for Every Man: Suggestions for Courses in Music Appreciation, address by W. P. Kent.
The Place of Music in National Education, address by Commissioner of Education, P. P. Claxton.
Ultimate Ends in Public School Music Teaching, addresses by Karl Gehrkens, Julia E. Crane, T. P. Giddings, C. H. Farnsworth, J. W. Beattie and G. O. Bowen.
Community Music in its Relation to the Supervisor of Music, addresses by P. W. Dykema, F. A. Beach, E. B. Gordon, Beulah Hootman, E. M. Hahnel, A. S. Osborn, W. P. Kent, Alice C. Inskeep, and E. L. Coburn.
School Credits for Music Study, addresses by Osbourne McConathy, H. D. Sleeper, W. O. Miessner, C. H. Miller and C. H. Farnsworth.
Classification of Children's Voices, topic by Hollis Dann. Discussion.
Report of the Committee on Pictures Relating to Music: List of material.
Music Programs.

1916: LINCOLN

Discussion of Class Instruction on the Violin.
Address of Supt. F. M. Hunter.
President's Address: Will Earhart.
Address: Place of Music in a Scheme of General Democratic Education: Dr. John W. Withers.
Discussion of High School Class Work.
Address: The Influence of Folk Music: Mr. Otto Kinkeldey.
Address: Co-ordination of Artistic Instruction: Prof. P. H. Grumman.
Topic: How a Supervisor May Aid in Making His Community Musical: E. B. Gordon,John W. Beattie, Will Earhart, P. W. Dykema, C. E. Strouse, T. P. Giddings.
Topic: The Teaching of Applied Music in Public Schools: Mr. Alfred White, Miss Lucy Haywood.
Address: An Analysis of Methods and Practice of Teaching Public School Music: Professor Walter Van Dyke Bingham.
Topic: Public Performance of School Music Work: Mr. Irving W. Jones.

These volumes may be purchased at $1.00 each, from the Treasurer, James McIlroy, Jr., McKeesport, Pa.

This arrangement obviates the use of slide bars and crosshead as in the case of the double-acting engine, thereby giving, in this particular, greater simplicity of construction. The length of the piston is usually about twice the diameter of the cylinder, or such that the pressure due to the tangential thrust of the connecting rod is kept as small as possible.

In the case of automobile and marine motors, the best practice makes the length of the piston equal to the diameter of the cylinder, and the length of stroke the same.

142. **Valves.** The admission and exhaust valves are invariably of the poppet type. Slide valves have been used in rare instances, but for many reasons they are absolutely unfitted for use in any type of internal combustion engine. Poppet valves are particularly well adapted for gas engine use on account of the facility with which they can be operated to satisfy the requirements of the various cycles, and their freedom from any liability to expand and stick under the influence of the high temperatures to which they are exposed.

Their dimensions are governed by the diameter of the cylinder and the piston speed. In calculating the areas of the valves, ports and passages, special attention should be paid to making them large enough to keep the velocity of the gas and air through the inlet and admission valves sufficiently low to prevent excessive friction, which, directly or indirectly, results in considerable loss of power. Present practice, in this connection, keeps the inlet flow at about 60 lineal feet per second for automatically operated valves, and 90 to 100 lineal feet per second for those that are operated mechanically, with the flow through the exhaust valve at about 80 feet per second.

143. **Valve Gears.** The general design of valve gearing varies according to the cycle of the engine and the methods of governing and ignition adopted.

The valve gearing of a two-cycle engine is usually very simple, as an impulse occurs during each revolution. Valves are frequently dispensed with, the piston itself serving to control either admission or exhaust, or both.

In the four-cycle engine, only one explosion is realized for

Fig. 36.—VALVES OPERATED BY BEV_L GEARING.
(Paragraph 143)

Fig. 37.—VALVES OPERATED BY SPIRAL GEARING.
(Paragraph 143)

every two revolutions of the crank shaft, thereby requiring a more complicated mechanism for the operation of the valves than is the case with the two cycle engine, as each valve must open and close only once in every two revolutions.

This action is usually obtained by means of a secondary or cam shaft driven from the main shaft by toothed wheels geared two to one, which cause the secondary shaft to make one-half

the number of revolutions of the main shaft, hence it is frequently termed the *half-speed shaft.* The secondary shaft may be driven from the main shaft by means of bevel wheels as shown in *Fig.* 36, or by spiral gearing as shown in *Fig.* 37. In either case it is placed horizontally alongside the engine and extends from the main bearing to the valve chest on the cylinder where it operates the valves by means of cams and rock shafts

Fig. 38.—VALVES OPERATED BY SPUR GEARING.
(Paragraph 143)

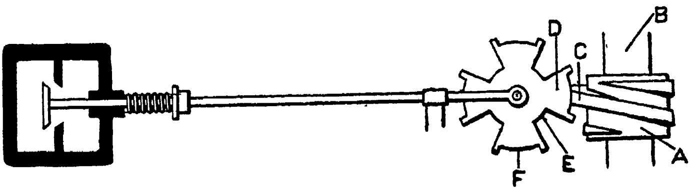

Fig. 39.—VALVES OPERATED BY WORM WHEEL CAM.
(Paragraph 144)

These methods are among the oldest arrangements employed for this purpose, and possess the great advantage of reducing to a possible minimum the size and weight of all the external moving parts of the engine. These plans also provide independent control of the valves at either end of a cylinder, in a double-acting engine.

Another plan is shown in *Fig.* 38. In this case the secondary shaft is driven from the main shaft by two to one spur gearing, and as it is comparatively short, the entire arrangement is more

efficient and is subject to less friction than those devices which employ either bevel or spiral gears. The valve rod is much longer, however, and the friction greater on account of the greater inertia, than in the others.

144. **Eccentric and Cam Arrangements.** There are several methods by which the valves and ignition devices may be operated without the use of a secondary shaft. In the arrangement shown in *Fig.* 39, a worm wheel A is mounted on the main shaft B. The middle thread of the worm wheel is swelled out

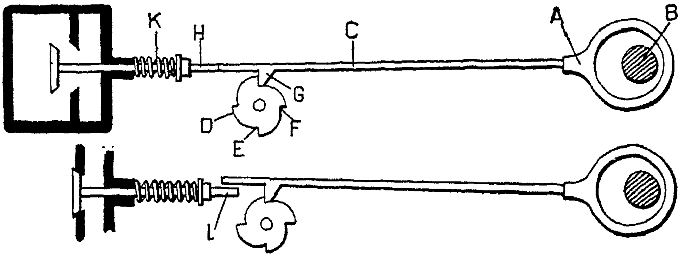

Fig. 40.—Valve Operated by Eccentrics.
(Paragraph 144)

to make a cam C, which engages the teeth of the star wheel carried on the end of the valve rod. The worm wheel turns the star wheel one space for each revolution of the main shaft, but the cam thread of the worm wheel pushes the valve rod only once every other revolution of the main shaft.

The action of the entire arrangement is as follows: when a tooth D of the star wheel is in line with the cam thread C, the cam pushes the valve rod and opens the valve. In the meantime, one revolution of the main shaft turns the star wheel one space and when the cam returns to its former position, it falls

into the space E of the star wheel, and therefore, cannot push the valve rod. It turns the star wheel, however, through another revolution of the main shaft, and when it returns to its original position a second time, it comes in line with the tooth F of the star wheel and again pushes the valve rod and opens the valve.

A simpler contrivance is shown in *Fig.* 40. An eccentric A mounted on the main shaft B, and the eccentric rod C, reciprocate over a ratchet wheel D. The notches in the ratchet wheel are alternately deep and shallow as shown at E and F. The eccentric rod turns the ratchet wheel one notch at each return movement, and causes the pawl G to fall alternately into the deep and shallow notches.

When the pawl falls into a deep notch, the end of the eccentric rod hits the valve stem H, and pushes the valve open. The eccentric rod is then drawn away by the rotation of the main shaft and the valve is re-seated by the action of its spring. When the eccentric rod returns, the pawl falls into a shallow notch, and being thus raised above the level of the valve stem, the eccentric rod misses it, as shown at L, and allows the valve to remain closed.

145. **Balance Weights.** The perfect balancing of a gas engine is a matter of great difficulty, as the intermittant nature of the impulses originating in the cylinder precludes the use of revolving weights driven at the required speed by gear wheels and cams, or the use of variable piston weights on odd crank angles. This is especially true in the case of a single acting engine, which, when properly balanced for horizontal vibrations will be found to be too heavily counterbalanced for vertical movement. The practice in this matter is quite varied and sometimes irrational. Some designs provide for the balancing of the rotating parts and make no allowance for the reciprocat-

ing parts; while in others, one-half of the weight of the reciprocating parts is added to the balance weights of the rotating parts. In some engines the counterweight is placed on the fly wheel near the rim, while in others the rim of the fly wheel on the side next to the crank is cored out.

As a matter of fact, a reciprocating part can be balanced perfectly only by placing another reciprocating mass in such a position that all free couples and free forces are eliminated by their opposed action.

It is obvious, that in the case of a two-cylinder engine this result can be obtained only by placing the axes of the cylinders on a common line so that the inertia forces are directly opposed, thus eliminating the couple which would exist in any two-cylinder opposed crank arrangement. The *vis-à-vis* cylinder arrangement with forked connecting rod, of the American Crossley engine, described and illustrated in paragraph 202, shows a good example of this method of balancing.

In the case of multi-cylinder engines, balancing by opposed cranks is comparatively easy, and becomes still more so with the increase of the number of cylinders. The general principle applicable to such cases consists in the setting of equal cranks at such angles that a given number of central cranks will oppose an equal number of outer cranks. In the case of an odd number of cylinders, as in a five cylinder unit, the central mass is doubled.

A general description of the construction and operation of the various types of governors and igniters will be found in the following chapters.

CHAPTER XII.

GOVERNING AND GOVERNORS.

146. **Methods of Governing.** The general principles of gas engine governing may be conveniently grouped into four distinct methods:

1. The hit-or-miss method in which charges of constant quality and volume are admitted to the working cylinder at variable intervals.

2. The method of qualitative regulation in which charges of constant total volume, but containing air and gas in variable proportions, are admitted to the working cylinder at regular intervals.

3. The quantitative method in which charges of variable total volume, but containing constant proportions of air and gas, are admitted to the working cylinder at regular intervals.

4. The stratification method in which charges of constant total volume, composed of a variable volume of pure air followed by a variable volume of air and gas of constant proportions, are admitted to the working cylinder at regular intervals.

The important factors in gas engine governing are those which affect the mean effective pressure. These may be generalized as follows:

1. The proportion of air and gas, and inert or neutral matter in the mixture which constitutes the charge.

2. The compression pressure attained before ignition.

3. The time of ignition.

4. The piston speed and the weight of the charge admitted to the cylinder.

When the pressures of the air and gas are different, it is practically impossible to maintain a constant ratio of air to gas under a variable load. The use of suction gas producer systems tends to obviate this difficulty as both the air and the gas are taken in at equal pressures by the suction of the piston, and in the case of any engine the same result may be obtained by the use of suitable devices which will supply both air and gas under the same pressure. But even under these conditions, the proportions of the charge to the neutral element will remain the same if the amount of mixture be varied either by the qualitative or quantitative methods.

147. **Hit-or-Miss Method.** In governing a four-cycle engine by the hit-or-miss method, the chance to regulate occurs only once in every two revolutions of the crank shaft, so that from two to five strokes of the piston will follow a shifting of position of the governor before the speed of the engine is affected by the change. For this reason, this method is practically inapplicable to engines employed for driving electric generators for lighting or other purposes requiring a constant current. Furthermore, it entails the great disadvantage of imparting heavy shocks to the reciprocating parts of the engine at every explosion regardless of the load, and requires the use of a much heavier fly-wheel than when the speed is controlled by throttling, in order to prevent excessive speed fluctuations between explosions, when running under light loads. On the other hand, the method is highly economical and affords more reliable ignition at light loads than is usually obtained by the throttling mode.

148. **Qualitative Method.** In this method the governor controls only the admission of gas by throttling or reducing the

area of the gas inlet. Although its application requires only the simplest forms of mechanical arrangements, it possesses the disadvantage of a great liability to miss fire at light loads, and also a tendency towards incomplete combustion at full load or at under load.

The total result of its application is characterized by a general irregularity of impulse, and a lack of ecomony due to a great waste of gas.

149. **Quantitative Method.** In this method, the inflowing mixture of gas and air is either throttled, or cut off entirely by the action of the governor.

The throttling method is the simpler and more satisfactory for smaller engines using either illuminating or natural gas, but it is inefficient at light loads. The cut-off method is more sensitive, though also more expensive for small engines, but it gives a higher economy at under loads. Both methods are, however, open to the serious objection that the final compression pressure is decreased as the load grows lighter, thus reducing the thermal efficiency of the engine, and consequently, the mean effective pressure, a result which is not economical. There is also a tendency to back-firing, late ignition, or failure of ignition, when using lean gas, such as blast furnace gas.

150. **Stratification Method.** This is the most satisfactory method for the governing of large gas engines, and especially for those using lean gases. In its application, pure air is admitted to the cylinder from the beginning of the charging stroke up to a point which is set either forward or backward by the action of the governor, and at which the mixture of air and gas in fixed proportions begins to enter the cylinder and con-

tinues to flow in until the end of the charging stroke. If perfect stratification could be attained, the contents of the cylinder at the end of the charging stroke would consist of a varying volume of pure air next to the piston, with an inversely varying volume of explosive mixture at the other end of the cylinder, and the surface of contact between the two volumes would remain a line of distinct demarcation even at the end of the compression stroke.

This condition, however, cannot be attained in practice as the natural tendency of gases to mix is increased by the act of compression, and varies in extent according to the amount of time available for that purpose.

In an engine making 90 revolutions per minute, this time is less than half a second, and, therefore, it is quite certain that at the instant of ignition the contents of the cylinder will be richest in the compression space at the head of the cylinder and poorest at the piston, a condition which under a constant maximum compression will insure reliable ignition, approximately perfect combustion, and high efficiency at all loads.

151. **Types of Governors.** Each of the methods of governing, defined in the foregoing paragraphs, may be practically applied by means of a great variety of mechanical arrangements which must, however, be designed to suit the cycle of the engine, its valve mechanism, and ignition device.

The various forms of valve mechanisms are fully described in Chapter XI, and the ignition devices in Chapter XIII.

The governors themselves are of a great variety of types, but they may be conveniently grouped into three general classes, pick-blade, centrifugal, and inertia governors.

152. **Pick-blade Governors.** *Fig.* 41, shows a type of pick-blade governor used on a Backus engine governed by the hit-or-miss method. A pendulum device, A, derives its motion from the eccentric rod, B, and actuates a pick-blade, C. At normal speed, the pick-blade hits the notch, D, of the push-blade carried on the end of the admission valve stem, and pushes the valve open at every other revolution of the crank shaft. When the speed increases, the pendulum oscillates more quickly and throws the point of the pick-blade upwards so that it misses the notch and fails to push the valve open, thus cutting off the supply of gas. The normal speed of the engine can be changed while it is in motion by simply adjusting the thumb nut, E, which limits the amplitude of the oscillation of the pendulum, and consequently the vibration of the pick-blade.

153. **Centrifugal Governors.** *Fig.* 42, shows a type of centrifugal governor used on a Foos engine, and operating on the hit-or-miss principle. At normal speed, the blade, A, on the fuel lever, B, operated by a cam on the gear wheel, C, strikes the notched finger D, on the end of the push rod, E, causing the fuel valve to open and admit a charge into the cylinder at each revolution of the cam. As the speed increases, the governor balls, F, move outward, causing the spool, G, to push against the roller, H, carried on the upper end of the governor lever, K. This action causes the lower end of the lever to move inwards and push the notched finger, D, out of its normal position, so that the fuel-lever blade, A, fails to hit it, and thus allows the fuel valve to remain closed.

The fuel supply being thus cut off, the speed decreases and the governor balls return to their original position, releasing the pressure on the lower end of the governor lever and allowing

the notched finger D to resume its regular position under the pressure of a spring.

It will be understood in this connection, that centrifugal fly-ball governors operating on the hit-or-miss principle may be attached horizontally to a transverse secondary shaft as in the foregoing case, or they may be placed vertically at the side of

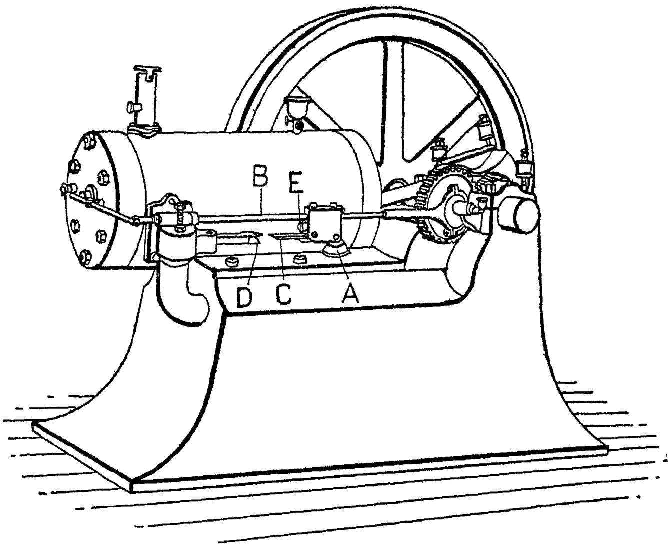

Fig. 41.—PICK-BLADE HIT-OR-MISS GOVERNOR.
(Paragraph 152)

the cylinder and receive their motion from a longitudinal secondary shaft through the medium of bevel gearing.

An example of the latter arrangement is given in the case of the Otto engine shown in *Fig.* 55, paragraph 193.

In another arrangement, very commonly used, the governor operates the admission valve through the medium of a bell-

crank, one arm of which moves the valve stem, while the other arm carries an impact roller which is capable of sliding on its axle.

The cam on the secondary shaft strikes the roller and raises or opens the valve against the tension of its closing spring.

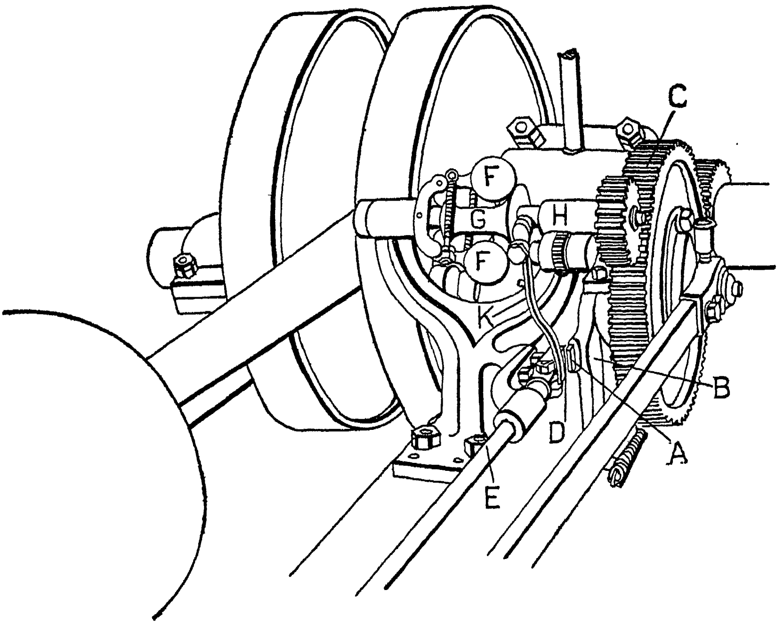

Fig. 42.—Centrifugal Hit-or-Miss Governor.
(Paragraph 153)

When the speed increases, the governor balls move outward, and the roller is shifted along its axle out of reach of the cam, so that the valve remains closed until the speed is reduced to the normal, when the inward movement of the governor balls brings the impact roller back again into line with the cam.

The use of a centrifugal fly-ball governor in connection with the throttling method is shown by *Fig.* 43, which represents the governor arrangement of the Strang engine.

The governor valve-casting is rigidly secured to the cylinder, with the gas opening in line with the air passage, A, leading to the air valve. The gas supply is received through the cock,

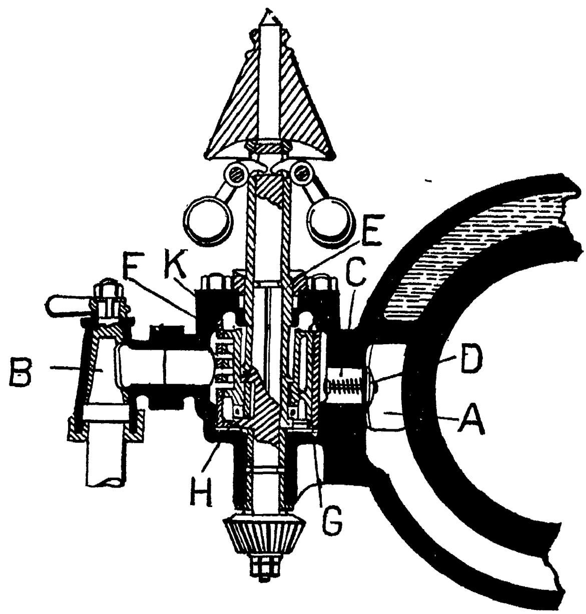

Fig. 43.—CENTRIFUGAL FLY-BALL THROTTLING GOVERNOR.
(Paragraph 153)

B. The passage, C, leading from the governor into the cylinder is normally closed by the check valve, D, which is held in place by a spring, and opened for the admission of gas into the cylinder by the suction of the piston. This valve also prevents the accidental escape of gas through the air passage when the engine is not running and the supply cock is left open.

The governor valve, E, is inserted loosely in the casing, and is separated from its wall by a liner, F, which leaves an annular space between itself and the wall. A number of ports are located on opposite sides of the liner; they open into the annular space and are separated from each other by a projecting vertical web G, which runs the whole length of the valve, thus completely preventing the effect of the suction induced by the piston from reaching the supply side of the governor valve.

The bottom of the liner is formed into an annular lip, H, on which the governor valve rests when in its normal position. The valve is hollow, of cylindrical cross section, and its exterior shell is provided with a series of ports which correspond to those in the liner.

The inner shell of the governor valve is provided with an annular shoulder which fits into a recess formed by the shoulder on the sleeve, and a nut which engages the lower end of the sleeve. By this arrangement, the governor valve is prevented from moving in a vertical direction independently of the sleeve. When the governor valve is in its normal position, it is supported on the lip of the liner and is not in contact with either the shoulder, the sleeve, or the nut, thus leaving a clear space for purposes of lubrication.

The upward movement of the governor valve is limited by contact with cap, K, and the valve is prevented from having a rotary movement by the lugs, at the lower end of the cap, which project through an opening in the valve and serve to keep its ports always in line with those in the liner.

The sleeve is feathered to the spindle of the governor so as to permit of both rotary and longitudinal movement. The lower end of the sleeve rests upon a collar on the spindle, the upper

end being provided with two lugs to which the arms carrying the governor balls are pivoted.

The governor spindle receives its motion through bevel gearing from the secondary shaft, and diminishes or increases the port openings in the valve according to the increase or decrease of the speed of the engine.

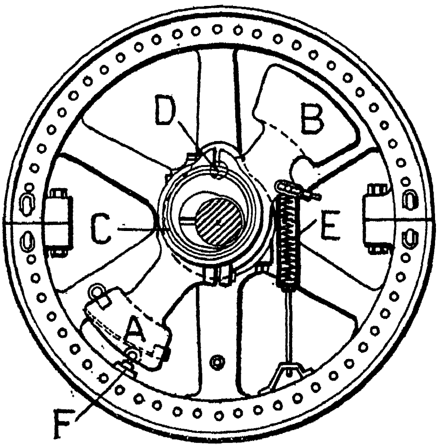

Fig. 44.—INERTIA GOVERNOR.
(Paragraph 154)

Centrifugal governors may also be attached directly to the fly-wheels or to the crank shafts. In both cases the centrifugal action of the governor-weights tends to shift the position of an eccentric across the center of the crank shaft. Illustrations of several examples are given in connection with the engine descriptions in the following chapters.

154. **Inertia Governors.** *Fig.* 44, shows the general arrangement of the Rites governor. The weights, A and B, are

balanced on the center line of the shaft arm which is attached to the eccentric, C, and pinned to the fly-wheel or pulley at D. The spring, E, holds the weights in normal position, their range of motion by differential momentum due to the variable speed of the engine being limited by the stop, F, on the rim of the pulley.

The governor may be adjusted in three different ways to satisfy the varying conditions of speed and pressure.

1. By changing the tension of the spring.

2. By shifting the point of attachment to the governor arm and thereby changing the leverage.

3. By adding weights to the arm, which is usually provided with panelled recesses for that purpose.

The action of a modified form of this governor is fully described in paragraph 201.

CHAPTER XIII.

IGNITION AND IGNITERS.

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155. Methods of Ignition. The charge in the cylinder of an internal combustion engine may be ignited by any one of the four following methods:

1. By means of a naked flame.
2. By means of a metallic surface having a high temperature.
3. By the spark of an electric arc.
4. By raising the temperature of the charge to its point of inflammation by compression.

The naked flame method is practically obsolete, and the hot surface or hot tube method nearly so, except in the case of some types of oil engine. Yet many of the makers of standard engines, both domestic and foreign, are always prepared to furnish the hot tube device with any type of gas, gasoline, or oil engine so desired. The electric method is the one most extensively used, and is rapidly replacing all others with the exception of the method of ignition by compression, which is the distinguishing feature of certain types of oil engine.

156. Moment or Point of Ignition. The point of ignition is the most important factor in the application of any method or device used for this purpose. For proper ignition, the moment at which the charge is ignited, and which corresponds to a certain point in the cycle of operations, should be neither too early nor too late relatively to the ending of the compression and the beginning of the power strokes.

When the moment of ignition occurs too early, the maximum pressure of the explosion is reached before the end of the compression stroke, thus retarding the motion of the piston, increasing the friction on the crank pin, and consequently reducing the brake horse-power.

When the moment of ignition occurs too late, the mean effective pressure is reduced, and consequently the brake horse-power also.

The highest efficiency is obtained by adjusting the point of ignition to suit the amount of compression, and the speed of the engine.

As an interval of time, no matter how short, must elapse between the moment of ignition and the moment of maximum pressure in order to prevent the delivery of a dead blow on the piston, the moment of ignition should occur immediately after the crank passes its inner dead center at the end of the compression stroke.

Furthermore, as the time of combustion or the interval of time between the moment of ignition and the moment of maximum pressure is not affected by variations in the speed of the engine; in order to obtain complete combustion and a resultant maximum pressure at the beginning of the power stroke, the moment of ignition should occur later for slow speed, and earlier and earlier as the speed increases.

157. **Hot Tube Igniter.** The hot tube consists of a short tube of metal or porcelain which is maintained at a dull red heat by contact with a gas flame, and which is attached to the engine cylinder in such a manner, that a portion of the explosive charge is forced into it, and, being ignited by contact with the hot walls of the tube, inflames the whole charge.

In the ordinary arrangement, the time of ignition depends upon the degree of compression. The products of combustion

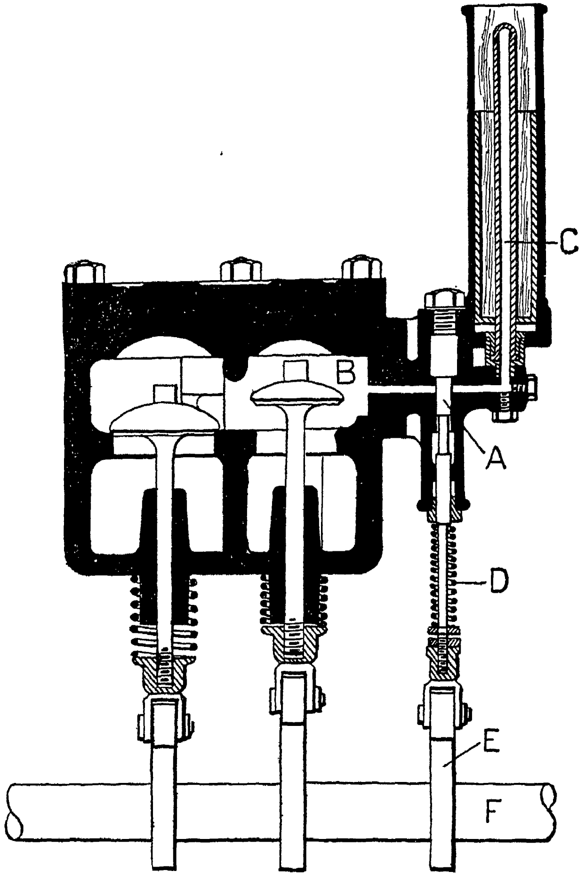

Fig. 45.—Hot Tube Igniter. (Timing Valves.)
(Paragraph 158)

remain in the tube and mix with the succeeding fresh charge, so that varying degrees of compression cause ignition at different

points of the piston stroke or cycle of operations. Under these conditions, the moment of ignition becomes later and later as the amount of compression decreases, until the compression becomes so weak that there is a failure to ignite.

For this reason, ignition by hot tubes is not satisfactory in the case of engines governed on the throttling principle, as the throttling of the charge always tends to diminish the pressure of compression.

158. **Timing Valves.** *Fig.* 45, shows a modification of the hot tube arrangement which is more exact and satisfactory. In this case, a valve, A, commonly called a timing valve, is interposed between the admission valve chamber, B, (communicating with the clearance space of the cylinder) and the interior of the hot tube, C. This valve is normally held closed by the spring, D. When the piston reaches its inner dead point at the end of the compression stroke, a cam, E, on the secondary shaft, F, opens the valve and allows a portion of the compressed charge to pass into the hot tube where it ignites. The timing valve is held open throughout the power and exhaust strokes, thus permitting the products of combustion to be carried out of the tube with the exhaust.

159. **Disadvantages of Hot Tubes.** Some of the dangers and disadvantages of using hot tubes are as follows:

1. The necessity for maintaining an open flame outside the cylinder is extremely hazardous in some localities, and is especially dangerous in the case of a gasoline engine.

2.. Uncertainty of the moment of ignition on account of variable compression.

3. Blowing-by or leakage at the piston rings, and consequent reduction in the amount of compression.

The application of the hot tube or hot head method in the case of an oil engine is illustrated by *Fig.* 114, paragraph 236, which shows the Meitz and Weiss igniter ball arrangement.

160. **Electric Ignition.** The most flexible method is that in which the charge is ignited by means of an electric spark, the current being derived from various sources of electrical energy.

The spark itself may be created in a number of ways, depending upon the mechanical construction of the igniter devices employed.

These devices are made in many forms, but may be grouped in two general classes, the make-and-break igniters, and the jump-spark igniters.

161. **Make-and-Break Igniters.** These devices may be divided into two general types, the hammer-break, and the wipe-contact igniters.

Both types employ a low tension current which cannot jump across the smallest kind of a gap in the circuit. Therefore, in order to produce a spark, it is necessary to first close the gap by metallic contact, and then separate the contact points quickly, by mechanical means, while the current is flowing through them.

Fig. 46, shows the general arrangement of a hammer-break igniter. It consists of two metallic terminals, A and B. The terminal, A, is mounted on the movable shaft, C, while the terminal, B, is stationary and insulated from the cylinder wall by the lava bushing, D. A suitable cam rod attached to the crank, E, provides the means for rocking the terminal, A, so as to bring it in contact with the terminal, B, and then quickly separate the terminals for the production of the spark. The helical

spring, F, provides a semi-flexible connection between the shaft, C, and the crank, E. The contact points of the two terminals are tipped with two small pieces of platinum, G and H, and both terminals are mounted in the removable plug, K, which is usually inserted through the walls of the cylinder head, so that the igniter points extend into the compression space of the cylinder.

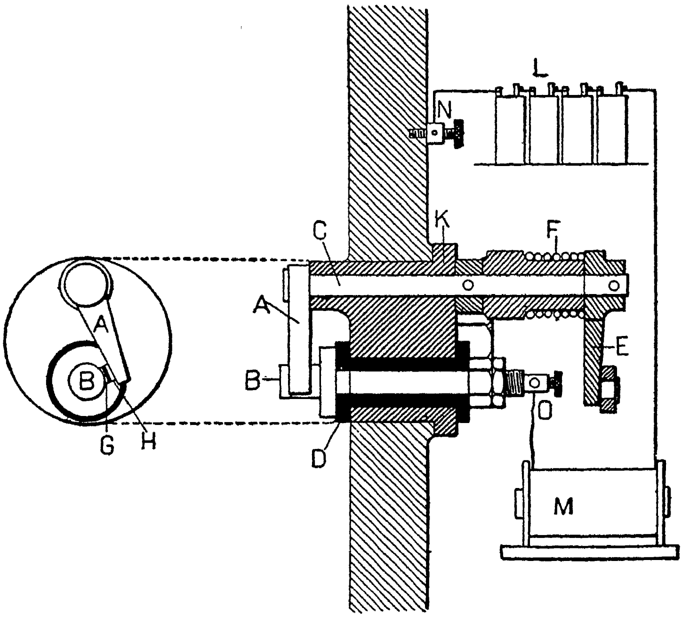

Fig. 46.—Hammer-Break Igniter.
(Paragraph 161)

The electrical equipment consists of a battery, L, and an inductive resistance or spark coil, M, with wire connections at N and O.

When the terminals are brought together, the circuit is closed through the battery and the spark coil, and when the terminals

are quickly separated, the self-induction of the spark coil causes the bright spark to pass between them and ignite the charge.

Fig. 47, shows the general arrangement of a wipe-contact igniter. It consists of two independent electrodes, the stationary electrode, A, and the movable electrode, B. When the latter is revolved by the motion of the igniter rod, C, the revolving

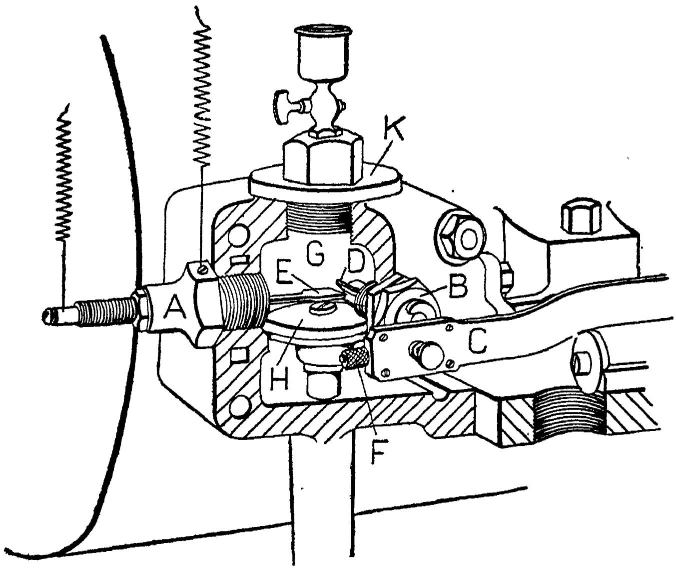

Fig. 47.—WIPE CONTACT IGNITER.
(Paragraph 161)

blade, D, is brought into contact with the spring, E, at each rotation and produces the spark. In this arrangement the break is more effective than in the hammer-break-type, and gives a larger spark with a given battery capacity, while at the same time, the wiping contact of the two parts prevents the accumulation of burnt carbon or scale on their edges, and thus serves to

keep the contact surfaces bright and clean. On the other hand, it possesses the drawbacks incident to the use of a spring which is exposed to the extremely high temperatures developed within the cylinder. The use of flat springs is particularly disadvantageous as it is very difficult to temper them uniformly, and they are consequently liable to break without warning. Furthermore, the wear of the electrodes is excessive.

The moment of ignition can be adjusted while the engine is running by turning the thumb screw, F, on the end of the igniter rod, and this screw is used also to retard the impulses at starting, thus preventing the engine from moving backwards.

The igniter is located in the inlet chamber, G, directly over the head of the admission valve, H, and either one of the electrodes can be reached for inspection or removal, independently, by simply removing the cap, K.

162. **Jump-Spark Igniter.** The various forms of these igniters employ a high tension current. A secondary coil of fine wire is wound around the primary spark coil, which upon making and breaking the circuit will generate a current of high voltage.

Fig. 48, shows the general arrangement. Both igniter terminals, A and B, are stationary, and are mounted in a spark-plug, C, of insulating material, usually of lava or porcelain. These terminals are connected to the secondary terminals, D and E, of the induction coil, and the primary terminals, F and G, of this coil are connected to the battery, H, at the moment of ignition by the contact cam, J, on the secondary shaft, K. The making and breaking of the circuit generates in the secondary coil a high tension current which jumps the perman-

ent gap, L, between the terminals, A and B, and causes a spark every time the circuit is broken.

163. **Vibrator or Trembler.** In many arrangements, especially those designed for high-speed engines, the primary circuit of the coil includes a vibrator or trembler, M, which insures the ignition of the charge by causing a succession of sparks to jump the gap between the igniter terminals while the circuit closing cam is in contact with its brush.

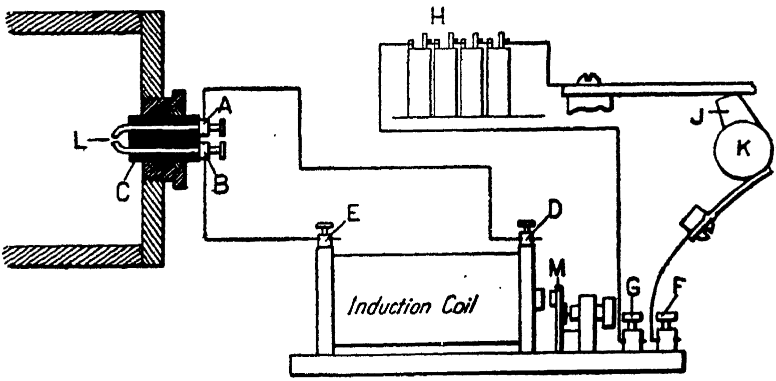

Fig. 48.—Jump Spark Igniter.
(Paragraph 162)

The principal advantages of the jump-spark method are the absence of moving parts and springs within the cylinder, and the simplicity of the mechanism. The principal disadvantage lies in the liability to short circuiting, that is, the gap between the terminals is liable to become connected by an accumulation of carbon on the surface of the insulating plug, thereby allowing the high tension current to pass through without jumping the gap, and consequently resulting in a failure to ignite.

164. **Igniter Dynamos and Magnetos.** Although the various methods of electrical ignition are far superior to all others, their weakest point is the source of the current. Heretofore, chemical or storage batteries have been employed for this purpose, but they are greatly affected by low temperatures, and faulty ignition is often due to the temporary polarization of dry batteries.

In order to obviate these difficulties, the present tendency is to generate the current mechanically by the use of dynamos or magneto-electrical machines.

The dynamos are of two distinct types, self-exciting and magneto dynamos. Their armatures are usually driven at a speed ranging from 1,500 to 2,500 revolutions per minute, by belt or friction drive from the main shaft of the engine, or from the line shaft, and generate a current ranging from 5 to 10 volts.

Their use obviates the necessity of frequently renewing exhausted batteries, and, in some cases, the use of an induction coil, the dynamos being capable of generating a current of sufficiently high potential to force a spark across the gap between the igniter terminals.

One objection to the use of dynamos is that they do not operate until the engine has been started, thus requiring the use of some auxiliary apparatus in the form of primary or storage batteries for starting. This difficulty is, however, satisfactorily overcome by the adoption of systems of wiring which provide for taking the current for ignition from a storage battery at all times, while the current from the dynamo is used for recharging the battery. This method insures a constant voltage, and thus obviates the necessity for adjusting the vibra-

tor of the jump-spark coil when the current is switched from dynamo to storage battery, or *vice versa.* Furthermore, it gives the operator two possible sources of current, thus enchancing the reliability of the ignition.

165. Wiring Dynamo or Magneto for Make-and-break Ignition. For make-and-break ignition, the general plan of wiring or connection is the same for both dynamos and magnetos, but it requires some modification in the case of the jump-spark.

Fig. 49, shows the plan usually employed. The generator may be placed on a low stand on the floor and connected by belt with the fly wheel, or, if it is to be driven by a friction pulley, it may be placed on some part of the engine frame so that the pulley will just touch the fly wheel when the generator is in the middle position.

If the generator is a dynamo, it is usually connected to run right-handed or clockwise, but if it is desired to run it in the opposite direction, this may be accomplished by crossing the leads going to the two brush holders from the field coils.

In the case of a magneto, it makes no difference in which direction the armature is revolved.

The wires leading from the generator and from the battery should be connected with the engine through the spark coil and the switch as shown in the figure.

Engines of three-horse power or less do not require batteries for starting, as a few rapid turns of the fly wheel by hand will produce a spark of sufficient intensity to ignite the charge. Engines of more than three-horse power usually require starting batteries composed of six or eight dry battery cells.

To start the engine, throw the lever of the switch so as to connect the battery with the engine, and as soon as the engine begins to run steadily, throw the switch lever so as to connect

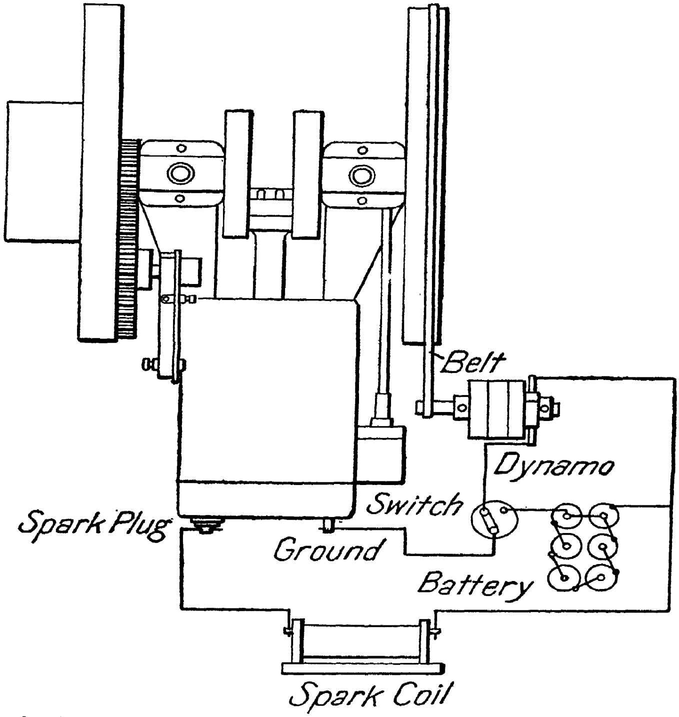

Fig. 49.—Wiring Dynamo or Magneto for Make-and-Break Ignition. (Paragraph 165)

the dynamo or magneto with the engine, and cut the battery out of the circuit.

When the engine is not running, leave the switch lever connected to the generator, and never throw the switch on the battery except for the purpose of starting.

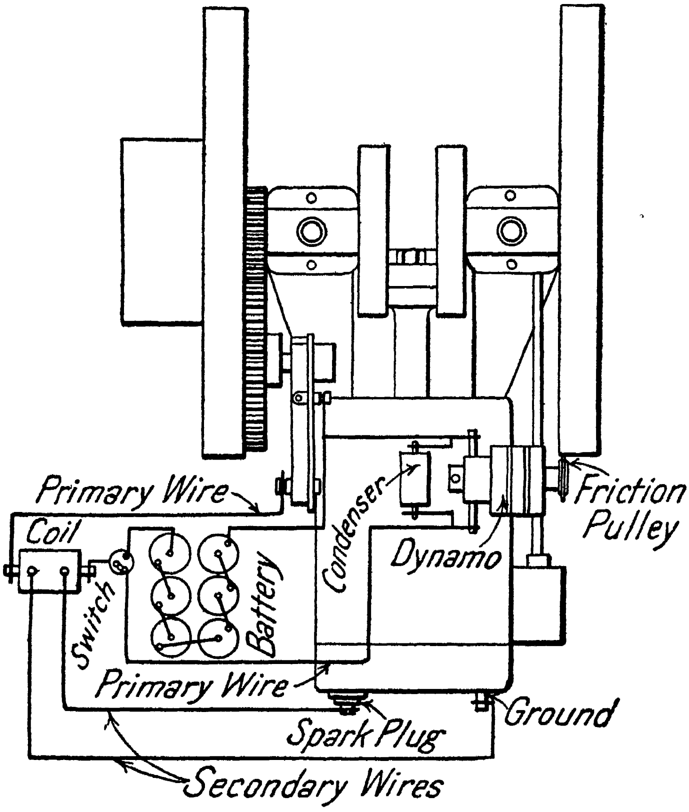

Fig. 50.—Wiring of Dynamos and High-Tension Magnetos for Jump Spark Ignition.
(Paragraph 166)

The oil cup should be filled with light, clean engine oil, at least once a month, and the commutator should be cleaned occasionally with a small piece of fine sand paper.

166. Wiring of Dynamos and High-tension Magnetos for Jump Spark. *Fig.* 50, shows the general plan of connection for a dynamo driven from the fly-wheel by a friction pulley.

The speed of the dynamo should be the same as that indicated on its name plate and it should be connected to run clockwise or right-handed, when viewed in the direction of the commutator.

The wires from the dynamo and battery should be connected to the engine through the switch and primary coil, and the wires from the secondary coil should be connected to the spark plug and the engine as shown in the figure.

The engine is started by means of the battery, and its operation continued with the current from the dynamo in the same manner as described in the preceding paragraph.

The brushes of the dynamo should press firmly on the commutator but not so as to bind, and if at any time the dynamo ceases to generate current, the commutator should be cleaned with a piece of sand paper.

When the dynamo is driven by means of a friction pulley, the latter should be arranged to just touch lightly against the fly wheel, as too much pressure tends to destroy the leather. Usually, the dynamo is furnished with a tension spring which serves to press the friction pulley against the fly wheel, thus obviating the necessity for using injurious tightening screws.

167. Igniter Points. The successful application of electrical ignition methods depends upon the effective action of the battery, the dynamo, or magneto, the spark coil, and the igniter points.

The igniter points should be good electrical conductors, and at least one of them should be effectively insulated from the metal of the engine.

They may be made of iron or hardened steel, German silver, platinum, or an alloy of platinum and iridium.

Soft steel points are more suitable for make-and-break ignition than for the jump-spark. In the former, the contact keeps them clean and produces a satisfactory spark for a much longer period than in the latter.

The principal advantage of iron or steel points is that they can be easily and cheaply renewed.

In fitting them, a small hole is drilled in the igniter part which holds the point, and the new point is placed in it and riveted in the proper position. In some cases, the hole is threaded and the new point screwed in and adjusted by a slotted head provided for this purpose.

Iron and steel points are, however, very liable to rust under moist atmospheric conditions, especially when the engine is not in constant use, and furthermore, they are liable to corrode under the action of the sulphur always present more or less in fuel gas. Both conditions tend to render the ignition uncertain if not impossible. Under such circumstances, it is advisable to use German silver points, or one point of German silver, and the other of steel, the latter being placed on the movable electrode.

Hardened steel is generally employed for the wiping parts of wipe-contact igniters, in order to enable them to withstand the excessive wear due to the wiping action, and such parts are usually so arranged that they can be readily adjusted to take up the wear.

The material most extensively used for igniter points, and one that works equally well on both make-and-break and jump-spark systems, is platinum and an alloy of platinum and iridium. Igniter points of these metals are not oxidized at any

temperature occurring within the engine cylinder, and are not subject to corrosion by any acid in gaseous form; while the alloy being much harder than the pure metal is much more satisfactory, and although more expensive, is nevertheless widely used.

The disadvantage of using any of them lies in the cost, the difficulty of attaching them to the electrodes, and their tendency to honeycombing. The last named condition usually gives a spluttering spark which makes the ignition uncertain at all times, and very often there is entire failure to ignite the charge.

168. Conditions for Reliable Action of Igniter Points. The reliable action of igniter points depends upon the following principal conditions:

1. At least one of the points should be effectively insulated from the engine to the source of electrical energy, and great care should be taken to prevent the current from passing from one igniter terminal to the other in any manner whatsoever except through the igniter points.

2. In make-and-break igniters, the faces of the points should be kept smooth, so as to insure good contact, and they should also be kept clean and free from deposits of grease, which by insulating them, will prevent the production of a spark.

3. Care should be taken against over lubrication, and the use of too rich an explosive mixture, so as to prevent insulating deposits on or about the points.

4. Corroded points should be carefully cleaned with a file, care being taken not to shorten the points to such an extent that they will not come in contact at all, or break contact too late and thereby fail to give a spark at the proper moment of ignition.

5. When the points are made of platinum, or an alloy of platinum and iridium, cleaning by filing is very expensive, as the points become worn down in a very short time. A more economical method of cleaning such points, especially when they are somewhat worn and pitted, is to use gasoline, and then punch them into the proper shape with a small cup punch.

6. In jump-spark igniters, the distance between the points ought not to exceed one-eighth of an inch, and the direction of the current ought to be changed about every two days, in order to prevent the rounding of the contact surfaces of the points by the deposits they receive from each other. This can be accomplished by simply changing the wires from one binding post to the other.

169. Ignition by the Heat of Compression. The method of igniting the charge by raising its temperature to the point of inflammation by compression is fully described in its application in the case of the Diesel engine, paragraph 239.

CHAPTER XIV.

INSTALLATION AND OPERATION.

170. **General Arrangement.** *Figs.* 51, and 52, show the relative positions of the motors and the accessory apparatus in a gas engine, and a gasoline engine, installation, respectively. It is obvious that the general arrangements thus shown may be deviated from in minor details for the sake of convenience, or such changes may be necessary on account of the peculiar structure of a particular engine.

It is equally clear, also, that in the case of all installations, the connections between the motor and its accessories should always be made in such a manner and the accessories themselves so placed, as to give the most efficient service in the operation of the engine.

In this connection, the principal points which require careful consideration are the following:

171. **Location.** The engine should be erected in a room as free from dust as possible, for the efficiency and life of an engine depend largely upon its being kept clean. The room should be well lighted, and care should be taken not only to place the machine at such a distance from the walls that all of its parts are easily accessible, but also to locate it in such a position relative to the shafting or machinery to be driven, that it will not be necessary to use a crossed driving belt.

172. **Foundation.** Engines employed for permanent service should never be bolted directly to a floor, as more or less trouble will be experienced from vibrations, but they should be set on properly built foundations of brick, stone, or concrete. The top plan of the foundation should conform to the dimen-

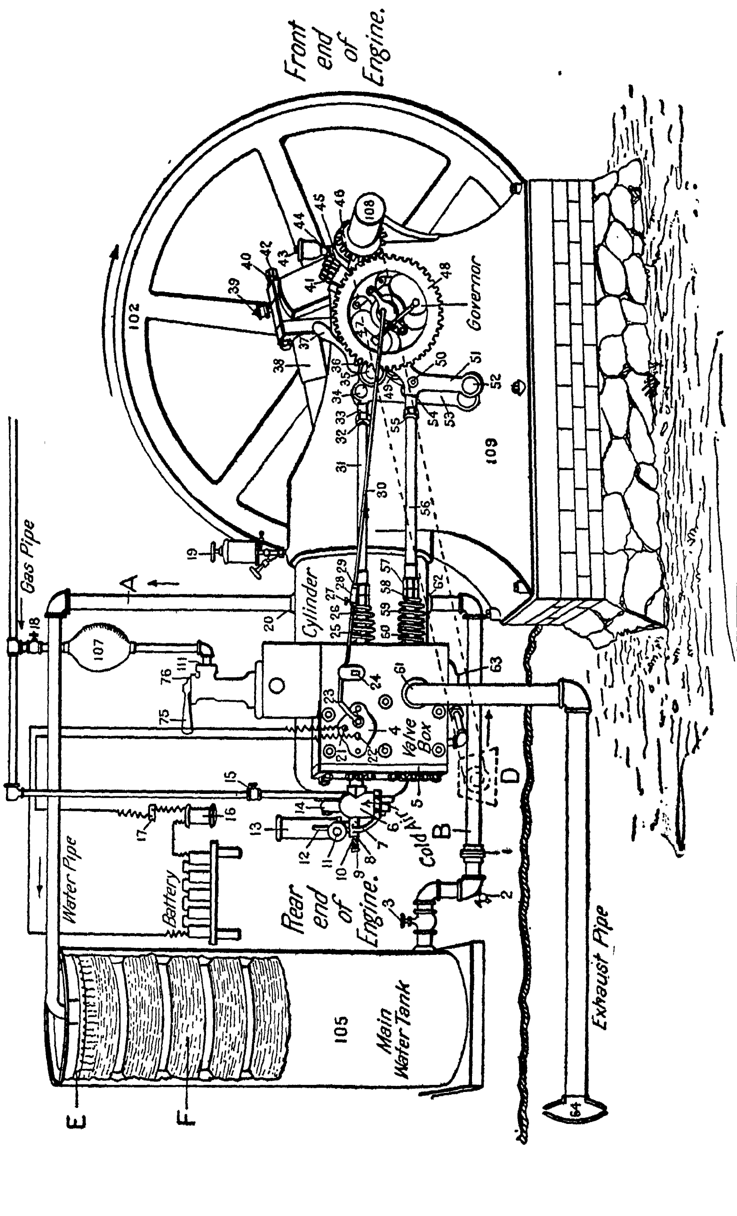

FIG. 51.—GAS ENGINE INSTALLATION.
(Paragraphs 137, 170, 177.)

Names of Engine Parts Corresponding to the Numbers on Figure 51.

1—Union.
2—Air Cock and Globe Valve.
3—Globe Valve.
4—Spark Igniter Plate.
5—Valve Chamber Plate.
6—Air Valve.
7—Timing Valve Casing.
8—Timing Valve.
9—Timing Valve Nut.
10—Timing Valve Spring.
11—Burner.
12—Nickel Alloy Tube.
13—Chimney.
14—Cylinder End Plate.
15—Globe Valve or Stop Cock.
16—Spark Coil.
17—Switch.
18—Globe Valve or Stop Cock.
19—Lubricator.
20—Waterpipe Connections, Overflow.
21—Set Screw
22—Insulated Electrode.
23—Trip of Spark Igniter.
24—Guide and Roller.
25—Receiving Valve Stem.
26—Receiving Valve Spring.
27—Set Screw.
28—Sleeve.
29—Lock-Nut.
30—Igniter Rod.
31—Side Rod.
32—Lock-Nut.
33—Long Rocker-arm Knuckle.
34—Long Rocker-arm Knuckle Pin.
35—Long Rocker-arm Roller and Pin.
36—Pin holding Trip.
37—Trip.
38—Connecting Rod.
39—Connecting Rod Lubricator or Grease Cup.
40—Connecting Rod Brasses.
41—Pillow Block Cap, Studs and Nuts.
42—Connecting Rod Studs and Nuts.
43—Pillow Block Lubricators or Grease Cups.
44—Position of Exhaust Cam when Engine is ready for starting.
45—Pillow Block Cap.
46—Crank Shaft Gear.
47—Split Nut.
48—Gear Wheel on Governor.
49—Short Rocker-arm Roller and Pin.
50—Short Rocker-arm Pin.
51—Short Rocker-arm.
52—Rocker-Arm Stud and Nut.
53—Long Rocker-arm.
54—Short Rocker-arm Knuckle.
55—Lock-Nut.
56—Side-Rod.
57—Side-Rod Sleeve.
58—Lock-Nut.
59—Exhaust Valve Spring.
60—Exhaust Valve Stem.
61—Exhaust Pipe Connection.
62—Water Pipe Connection.
63—Air Port.
64—Muffler or Silencer.
75—Gas Valve Handle.
76—Dial Plate.
102—Fly Wheel.
105—Water Tank.
107—Gas Bag.
108—Crank-Shaft.
109—Bed Plate.
111—Gas Pipe Connection.

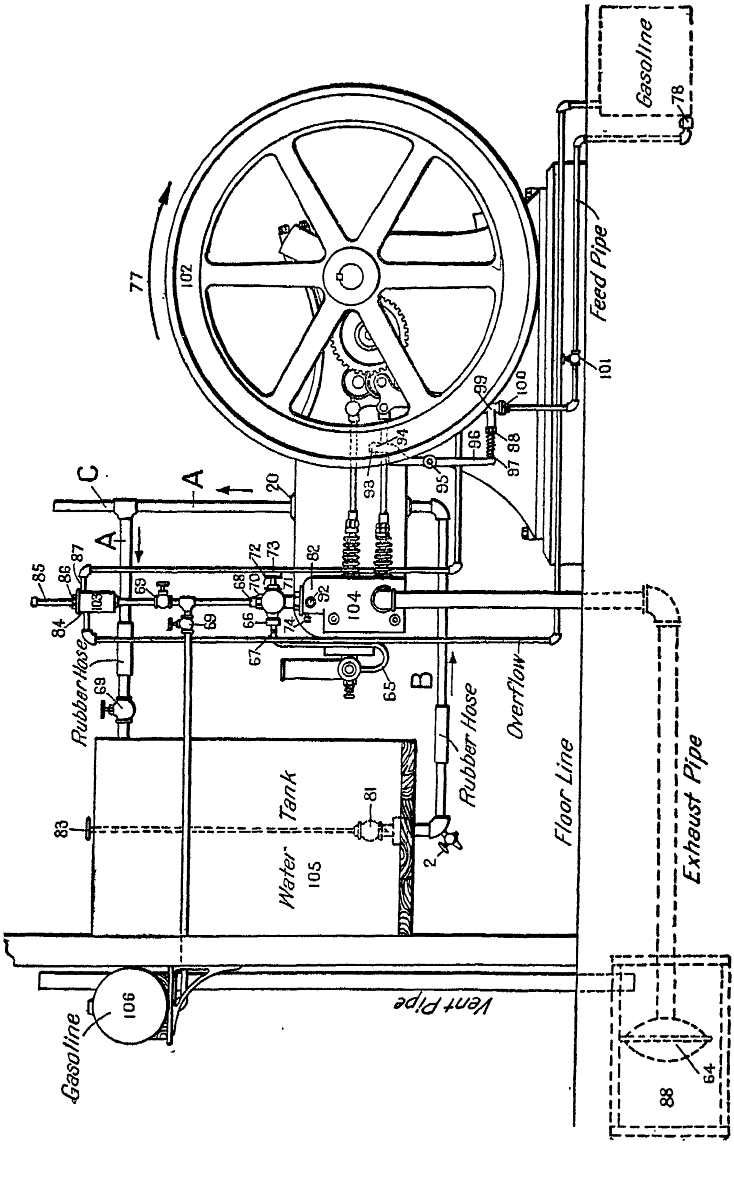

FIG. 52.—GASOLINE ENGINE INSTALLATION.
(Paragraphs 137, 170, 177)

Names of Engine Parts Corresponding to the Numbers on Figure 52.

2—Air Cock and Globe Valve.
20—Water Pipe Connection, Overflow.
64—Muffler or Silencer.
65—Burner Pipe.
66—Packing Nut.
67—Short Ferrule.
68—Long Ferrule.
69—Globe Valve.
70—Packing Nut.
71—Dial Plate.
72—Dial Pointer.
73—Needle Valve and Handle.
74—Set Screw.
77—Arrow, Direction of Normal Revolution.
78—Check Valve.
81—Shut-off Valve Inside of Water Tank.
82—Disc Gas or Gasoline Valve inside of Valve Box.
83—Shut-off Valve Handle.
84—Overflow Pipe Connection.
85—Nipple in top of Gasoline Cup.
86—Top of Gasoline Cup.
87—Feed Pipe Connection.
88—Underground Muffler Box.
92—Bull's Eye or Nut.
93—Set Screw.
94—Side Rod Lug.
95—Pump-arm Stud.
96—Pump-arm.
97—Pump Plunger and Spring.
98—Packing Nut.
99—Pump.
100—Pump Nut.
101—Globe Valve.
102—Balance Wheel or Fly Wheel.
103—Gasoline Cup.
104—Valve Box.
105—Water Tank.
106—Gasoline Tank.

sions of the engine base. The depth and form below the ground will vary with the character of the soil, being more splayed toward the bottom in light and yielding soil than in solid ground. The depth will vary according to the weight of the engine, or according to its power. In general, the following depths will be satisfactory, 35 inches below the floor level for engines up to 5 horse-power, 45 inches for engines up to 10 horse-power, 65 inches for engines up to 25 horse-power.

As a rule, the foundation bolts should reach down to within one foot of the bottom of the foundation. They should be placed in pieces of metal piping having an inside diameter one-half inch larger than the diameter of the bolts, so as to compensate for any slight deviations in the distances between them, either in the foundation or in the engine frame.

Furthermore, when the engine is finally bolted down, great care should be taken to tighten the bolts evenly, otherwise the frame will be strained, and the main journals thrown out of line, with the result that they will become heated.

Before keying the fly-wheel on the crank shaft, the frame should be levelled up and tightened down, so as to indicate whether the crank moves freely in every position. When the caps over the main bearings are screwed down tight, the throw of the crank shaft ought to drop by its own weight. A failure to do so indicates that the top of the foundation is not level. In this case it will be necessary to level the engine by the use of wooden wedges placed between the engine bed and the top of the foundation. All level measurements should be taken from the secondary shaft and the main shaft.

173. **Inclination of Engine.** In erecting a horizontal engine, always incline the cylinder towards the crank shaft. If

the cylinder inclines towards the rear, lubricating oil will accumulate in the combustion chamber and cause serious trouble.

174. **Fly-wheels and Keys.** Fly-wheels should always be carefully handled, as rough usage such as rolling them down steps, etc., is very liable to damage the turned surface. When keying them on the shaft, care should be taken to use the proper keys in the correspondingly marked key ways, and in driving them into place both should be driven at the same time, so as to avoid the forcing out of the wheel from its true position by either one of the keys.

175. **Crank Shaft and Gear Wheel.** When the crank shaft is placed in its bearings, care should be taken to see that its pinion matches with the spur or bevel wheel so as to bring the tooth marked O in one wheel into the space similarly marked on the other.

176. **Valve Setting.** The O marks on the wheels indicate the shop setting. They come together on all two to one gears every other time, and on all one to one gears every time the crank reaches its inner dead center. This system of marking is applied to all toothed wheels used on an engine.

In a multi-cylinder engine, care should be taken to set the admission cam-shaft gears so that all the marks will come together simultaneously when the center crank reaches its inner dead center. On the other hand, if by mistake, the setting is such that the exhaust cam-shaft gears come together when the crank reaches one inner dead center, and the admission or inlet cam-shaft gears come together at the following inner dead center, it will be impossible to start the engine.

177. **Cooling-Water Connections.** All matters relating to

the supply and circulation of cooling water will be found fully described in paragraph 137, and Chapter XXV.

178. **Exhaust Pipe, and Silencer or Muffler.** The extension of the exhaust pipe will vary according to local conditions, and the kind of silencer or muffler employed. In all cases the exhaust gases should be carried through the silencer into the open air, avoiding a waste-pipe extended above the roof of the building if possible. This pipe should never be turned into a flue, chimney, or drain, unless the pipe is continued through their entire length. Care should be taken to avoid bends or elbow joints, and long horizontal sections, which tend to produce condensation and thus develop back pressure, which will ultimately stop the engine.

179. **Valve Gears, Governors, and Igniters.** The various forms of valve gear arrangements, governing mechanisms, and igniter devices, and instructions relating to their construction, attachment, and operation, will be found in Chapters XI, XII, and XIII.

180. **Conditions for Successful Operation.** The successful operation of a gas engine depends upon four important conditions,—the proper mixture of the fuel and air, the proper amount of compression, the correct timing of the ignition, and effective lubrication.

When once started, the action of a gas engine is practically automatic, and everything being in proper adjustment, it will continue to run as long as the supply of gas and air, electric ignition current, cooling water, and lubricating oil are not interrupted. It is a serious mistake, however, to think that one of these engines can be started, stopped, or operated for an indefinite length of time without any attention being paid to it except to periodically open and close a few cocks and valves.

Before an engine leaves the factory, it is always operated and tested under certain given conditions, and adjusted to run in those circumstances in the most satisfactory manner, and if at any subsequent time it fails to operate equally well, it is obvious that some deviation from those normal conditions exists, and demands an inquiry into its nature and extent.

For this reason, when starting an engine for the first time, as after erection, it is well to note the positions of the various marks which indicate the shop setting of the valves, the point on the gas cock dial at which the engine starts, etc., and mark them for future reference.

181. **Starting the Engine.** Everything being in working order, the starting of the engine is a very simple matter, but it should always be preceded by the following operations exactly in the order given.

1. Always keep the engine cleaned of all dirt and dust, and immediately before starting, see that all nuts and bolts are tight, and all split pins in place.

If the engine is of the inclosed crank-case type, fill the crank case with good heavy oil of about 450 to 600 degrees fire test, so that the connecting rod dips into it about three-quarters of an inch. Then thoroughly oil the bearings and cams, the governors and all moving parts, with good lubricating oil; lubricate the valves by puting heavy cylinder oil in the cages through the holes which are usually drilled in the valve stem guides; fill the sight feed lubricators on the cylinder, setting them to feed about six drops per minute; and fill the oil cups on the cam shaft, having adjusted them to feed about two drops per minute.

2. If the engine is provided with a hot tube igniter, turn on the gas to its burner and light it. The flame should be of an

almost invisible blue color, similar to that of a gas stove. If the flame burns yellow, it shows imperfect combustion due to too little air, or that it has lit back. Turn the adjusting screw and give it more air, and if that is not successful, blow it out and relight; get a blue flame and let it burn until the tube has been heated to a dull red heat, before starting.

If an electrical igniter is used, see that the igniter points are bright and clean, and that there is sufficient current to give a good spark. With dry batteries the current should never be less than 6 volts for make-and-break ignition, and should run up to about 10 volts for jump-spark. Test the current by placing a screw driver or other small piece of metal so as to connect the terminal rod and the igniter stem when the igniter points are separated. The spark should be of a reddish color.

If the engine be very cold, remove the igniter cover and warm it so as to prevent the condensation of moisture on the parts from the first explosion, which is very liable to short circuit the igniter.*

For starting, set it as late as possible, as an early spark makes the engine work against itself, and it is therefore harder to start. After starting, the time of ignition can be changed to suit the quality of the gas, or the speed of the engine.

After testing the current, turn it on at the switch.

3. If the engine operates with gasoline, see that there is sufficient gas at the engine by lighting it at the pet cock usually

*The adjustment of the igniter will vary according to the character of the fuel used. For illuminating and gasoline gas, it should break or spark at the moment the crank reaches its inner dead center; for natural gas, it should spark from 5° to 20° earlier (depending on the quality of the gas); and for producer gas about 30° before the crank reaches the same dead center.

located close to the gas valve. It should burn steadily like an ordinary gas jet. If it burns violently, it indicates the presence of air in the gas pipe. This air should be pumped out either by turning the engine over by hand, or by self-starter, with the gas adjustment wide open and the air adjustment closed. If the pressure at the engine is too low, it indicates something wrong with the regulating device. Jar the regulator until it works freely. If the pressure in the main is too low, open the gas adjustment wider than usual.

Set the mixing valve adjustment in the best position for starting, according to the quality of the gas. Adjust the valves so as to give, for illuminating gas, a proportion of 1 to 6 or 10; for natural gas, 1 to 12 or 16; and, for producer gas, about 1 to 1 or 2.

The point of starting depends upon the pressure and quality of the gas.

4. If the engine can be turned over by hand, as is the case with all engines below 25 horse-power, and a great many up to 50 horse-power, turn the gas valve handle slowly, beginning at the 0 on the dial plate; turn the fly wheel backward until it cushions, then forward two or three quick turns, all the way around, and the engine will start.

5. As soon as the engine is started, turn the gas valve handle to the highest mark (10) on the dial. Move the gas and air adjustment to the best running position, and then turn on the cooling water. The cooling water should never be turned on before starting, except in cases where the jacket-water has been previously drained, as a warm engine is much easier to start than a cold one.

If the engine is to be started by compressed air, open the air cocks, at the tanks, so as to fill the pipe leading to the engine

with compressed air. Open the gas valve, and immediately thereafter open the compressed air cock at that cylinder which is temporarily used to run the engine with compressed air. As soon as good explosions occur in the other cylinders, shut off the air cock, throw in the inlet-cam clutch of the starting cylinder, so that it will admit gas for its own explosions. Care should be taken to shut off the air cock before the inlet-cam clutch of the starting cylinder is thrown in, otherwise this cylinder may compress a charge of air to such a high pressure that it will reverse the piston with disastrous consequences.

6. If the ignition current is obtained from a dynamo or magneto, turn the current on from the dynamo, and cut out the battery from the spark coil circuit.

7. Pump up and lock the air tanks at the pressure required to start the engine. The pressure varies according to the type and horse-power of the engine, and ranges from 100 to 250 pounds to the square inch.

182. **Failure of Engine to Start.** If the engine fails to start, it may be due to one or more of the following causes:

1. The mixture may not contain a proper proportion of gas to air. A mixture either too rich or too lean will fail to ignite. Also, a poor mixture burns so slowly that it might ignite the incoming charge, and cause back-firing. Readjust the mixing valves.

2. The use of a too volatile lubricating oil will produce the same effect. Change the oil.

3. Accumulations of dirt under the admission valve may cause it to leak, thereby allowing the flame to blow-by and cause premature ignition. Clean and re-grind the valve seat with flour emery.

4. A leaky exhaust valve will lower the compression below the point required for ignition, and cause miss-firing. Re-grind the valve, so that it will seat firmly and quietly under the pressure of compression.

5. The igniter points may be dirty, or coated with the moisture of condensation, or they may be too far apart. Clean them with a little gasoline, or with a small piece of No. 0, emery paper, and place them one-sixteenth of an inch apart.

6. Test the ignition current, the battery, the dynamo, the spark coil, and the wiring.

7. The pawls or trips which operate the gas valves may not operate at the right time. Adjust them by tightening or loosening the adjusting screws in the governor collar on the fly wheel.

183. **Management of Engine.** The principal points to which careful attention should be given while the engine is in operation, are as follows:

1. The main bearings should not be allowed to get hotter than the engine frame, or the crank case, while the small bearings which are not heated by the cylinder should be properly lubricated and adjusted to run cool.

2. The jacket-water should not issue from the cylinder at a higher temperature than 150° Fahr., nor colder than 100°, otherwise there will be a great loss of power. The supply of jacket-water must never be interrupted while the engine is running.

3. The igniter cams should be oiled or greased several times a day in order to prevent them from running dry, squeaking and cutting. Likewise, the admission cam shaft, and other small shafts, should receive a few drops of oil or a little grease every three or four hours.

4. Miss-firing must be prevented.

5. All unusual sounds should be carefully observed, their cause located, and the trouble remedied at once. Especial attention should be paid to sounds caused by the improper action of valves.

In short, the engine should run quietly.

6. Effective lubrication should be maintained.

184. **Stopping the Engine.** To stop the engine, it is necessary to execute the following operations exactly in the order given.

1. Shut off the supply of jacket-water.

2. Shut off the supply of gas.

3. If the igniter current is derived from a battery, switch the latter out of the spark coil circuit. Never leave the battery short circuited, as it will exhaust itself very quickly and require frequent renewals.

4. Throw out starting levers, if there be any, before the engine stops, so as to prevent the engine from turning backwards.

5. Stop the engine in the starting position, otherwise the exhaust valve will be left open, and the outer air will corrode the valve seat and prevent the valve from closing tightly.

Where more than one engine exhausts into the same pipe, close the valve in this pipe as soon as each particular engine stops, otherwise the engines still in operation will drive water into the cylinders of those at rest.

6. Close sight-feed lubricators and oilers, so that they will stop feeding.

7. In freezing weather, drain the water from the water jacket and pipes, and remove the igniter plug.

185. **Care of Engine.** In order to insure its effective operation, a gas engine should receive intelligent care regularly.

186. Inspection. Inspections should be made often and systematically. In the inclosed crank case types of engine, the hand-hole covers, igniter-plug covers, and valve covers may be readily removed, so as to allow the inspection of the internal working parts.

187. Igniters. The igniters should be removed and examined at least once a week. Those of the make-and-break type require especial and frequent attention. Their points should be kept clean and dry, and their joints tight so as to prevent them from leaking and thus becoming heated. Care should be taken to see that the igniter stems show no signs of sticking, and that the lava or other insulators are not cracked.

188. Valves. The valves should be examined at least once a month, especially the exhaust valve, and if they are discovered to be leaky, their seats should be immediately re-ground, and the valve stems and valve heads properly cleaned. Leaky exhaust valves become burned very quickly, which tends to lower the compression and results in much loss of power.

Water-cooled exhaust valves are liable to become stopped up with scale, so that their stems get heated. They should be removed and the scale punched or drilled out of the small holes below the valve seat.

Admission valves seldom require grinding, but should always be kept clean.

189. Pistons. The pistons should be examined at least twice a year. For proper inspection, a piston should be drawn far enough out of the cylinder to permit of the removal of the piston rings, if necessary, and for the thorough cleaning of the piston ring grooves.

The piston rings should not be allowed to stick tight in the grooves on account of accumulations of rust, dirt, or baked oil. They can be readily cleaned with petroleum, and if any of them are broken, the pieces should be taken out at once and new rings substituted. In putting on new rings, great care should be taken not to bruise, nick, twist, or injure them in any way that will prevent them from expanding freely in the grooves. A twisted or bruised piston ring will not bear evenly against the walls of the cylinder, and will very quickly wear the latter out, causing serious blowing-by or leakage of both the compressed and expanding charges, and consequently a great loss of power. When the erosion of the cylinder has become too excessive to be remedied by the normal expansion of new piston rings, the proper and only thing to be done is to have the cylinder rebored. Care should be taken to see that the rings are not too loose in the grooves, and if such be the case, they should be exchanged for correct-fitting ones at once.

190. **Cleanliness and Carefulness.** It is essential that the engine be kept clean at all times. Whenever the machine is started cold, the subsequent heating tends to loosen all bolts and nuts. It is absolutely necessary that they should be kept tightened at all times. If the bolts and nuts on the cylinder head are allowed to work loose, the force of the explosions is liable to blow the joint out of the cylinder cover. In tightening nuts and bolts great care should be taken not to overstrain them, or they will be very liable to breakage, either during the act of tightening, or subsequently under the expansion of the engine itself.

191. **Lubrication.** Proper lubrication, and the use of a suitable oil for this purpose, are of more importance in the case of a gas engine than in any other piece of mechanism.

As to the quality of oil, any kind or plain engine oil cannot be used. No vegetable or animal oil should be used for this purpose. In fact, nothing but a mineral oil of high flash point can be used at all. Gas engine oil must possess what is commonly called *"body,"* or the capacity to retain sufficient viscosity, under the thinning influence of heat, in order to lubricate effectively. Oil susceptible of being readily burned will not only deposit carbon and gum on the cylinder walls, piston heads, and spark plugs, but will also form injurious deposits in the piston ring grooves and between the rings, thereby greatly interfering with their free expansion, and causing leakage and faulty compression.

Even when using the most suitable kind of oil, gas engine lubrication has to be very carefully arranged, especially in the case of high speed engines.

In all cases, the principal condition which must be satisfied is the delivery of the proper quantity of oil to the different working parts of the engine. The feeding of too small a quantity of oil will result in great damage to the cylinder by scoring, and to the bearings by cutting and excessive wear. On the other hand, the delivery of too much oil will result in fouled igniter plugs, causing short circuiting; smoky exhaust; carbon deposits on the piston heads and cylinder walls in sufficient quantity to cause pre-ignition, and decrease of the clearance space causing over-compression and consequent pounding of the engine.

The usual lubricating arrangements consist of various forms of sight feed lubricators and oil cups for the cylinders, pistons, wrist pins, cam shafts, etc., which can be set to feed the exact quantity of oil required for the proper lubrication of those parts under varying speed. The main bearings are usually

equipped with ring oilers as shown in *Fig.* 53. The rings, A and B, move freely with the main shaft and dip into the oil reservoirs, C and D, which are filled through the funnel-shaped holes, E and F, in the bearing caps, G and H.

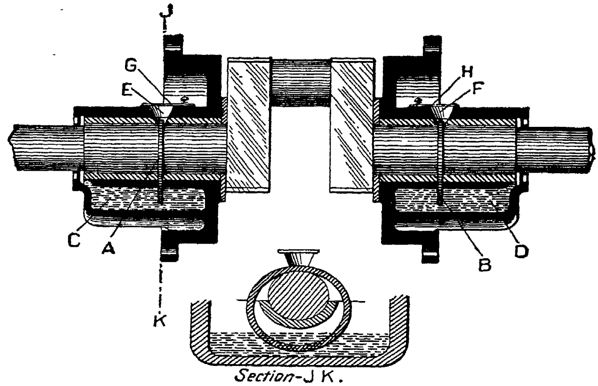

FIG. 53.—RING OILER.
(Paragraph 191.)

CHAPTER XV.

FOUR-CYCLE HORIZONTAL ENGINES.

192. **Horizontal, Single-Acting Engines.** The machines described in this chapter represent some of the standard types of modern gas engines. The majority of them are readily convertible into gasoline and oil engines by the use of the necessary carburetters or vaporizers, but oil engines, proper, or those especially designed for using liquid fuel in the form of kerosene, crude petroleum, distillates, etc., are described in Chapter XX.

The engines herein described have not been selected for that purpose because they were considered the best of their kind on the market. A great many other makes represent quite as fine workmanship, and possess equally as good power-producing capacities. The present selection is made rather with a view to the description of certain standard forms which appear to cover all the peculiarities of construction of the best types of modern gas and gasoline engines belonging to the four-cycle, single cylinder, horizontal, single-acting type.

193. **The Otto.** The construction of the Otto engine was begun in 1867. It was the first practically successful engine of the four-cycle compression type. At the present time it is built in sizes ranging from the smaller powers to 200 horsepower. The frame is of substantial pattern with well-rounded corners and a broad bearing on the foundations. The cylinder overhangs the frame, and in the larger sizes is supported by a heavy cylinder-foot immediately in front of the valve gear. The

engine is equipped with a long connecting rod which serves to lessen the vertical thrust upon the piston, thus adding to the tightness and durability of both piston and cylinder by diminishing friction and consequent wear.

Fig. 54, gives a general view of a 50 horse-power engine; *Fig.* 55, an enlarged view of the side of the cylinder; and *Fig.* 56, a similar view of the end of the cylinder.

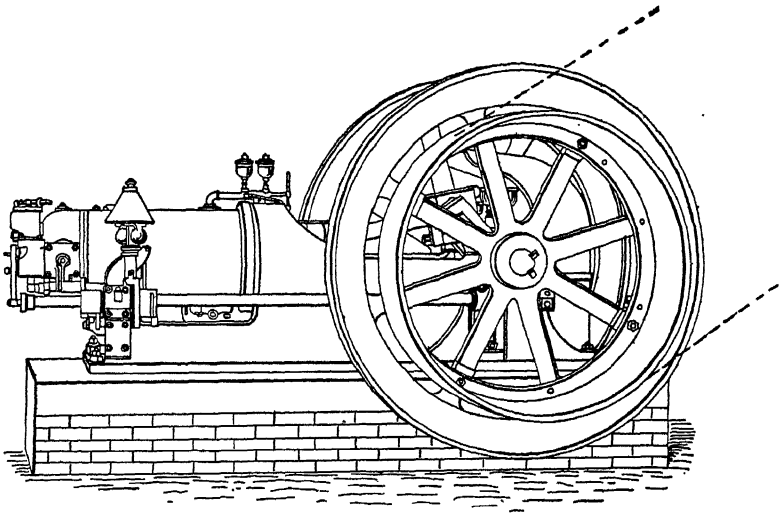

Fig. 54.—50 HORSE-POWER OTTO ENGINE.
(Paragraph 193)

The arrangement of the parts varies somewhat in the different designs, but the general action is practically the same in all sizes.

Referring to *Fig.* 55, when gasoline is used, it is delivered by the gasoline pump driven by an eccentric on the side shaft, into the standpipe from which it gravitates to the gasoline valve, A, which regulates the quantity of gasoline and the time

of its admission, so as to supply automatically the proper mixture of air and gas according to the requirements of the varying load. The valve, A, is operated by the cam, B, on the side shaft, C, the cam actuating a rocker shaft, D, the lower arm of which is fitted with a long pin which carries the gasoline roller, E. This roller has a free lateral movement which is governed

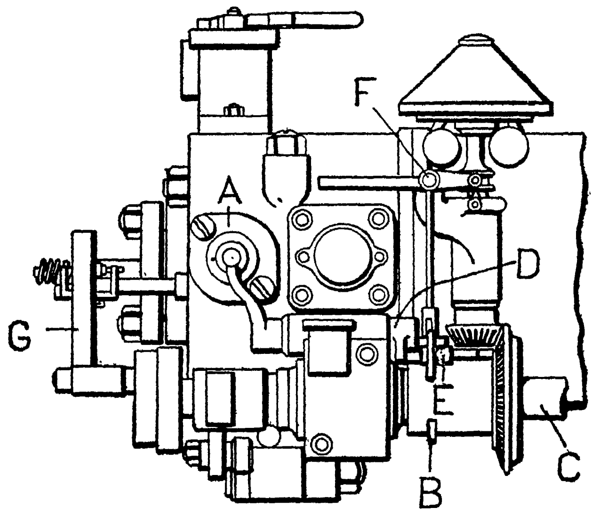

Fig. 55.—OTTO ENGINE CYLINDER.
Enlarged View of Valve Gear Side.
(Paragraph 193)

by the vertical arm of the bell crank, F, connected with the governor, a very slight movement of which is sufficient to place the roller in or out of engagement with the cam on the shaft. The speed of the engine is regulated by the governor which changes the position of the gasoline roller, so that the fuel is admitted only when the speed is normal or slightly below it. The governor is of the fly-ball weighted type.

Ignition is effected by an electric spark, the igniter being operated by the igniter lever, G, actuated by the side shaft. The electrodes of the igniter are tipped with platinum, and the current is derived from a primary battery.

As shown in *Fig.* 56, the exhaust valve, H, is operated by the exhaust lever, J, fulcrumed beneath the cylinder, and actuated by a cam on the side shaft. The cylinder, cylinder head, and

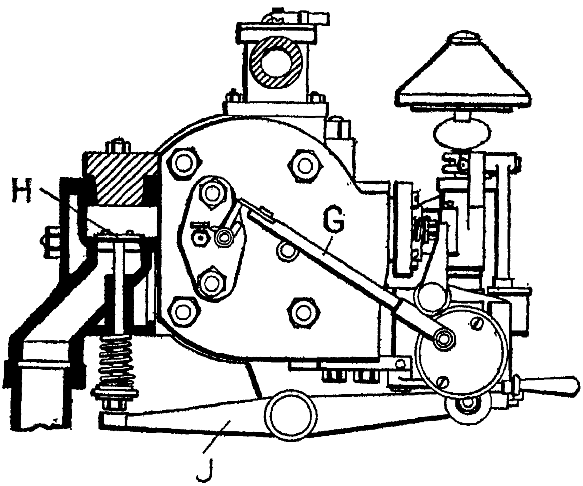

Fig. 56.—Otto Engine Cylinder.
Enlarged View of Cylinder End.
(Paragraph 193)

exhaust valve box are amply water-jacketed. The piston and the crosshead pin are lubricated by means of special oil cups placed on the cylinder near the front end. The crank pin is oiled by means of a wiper fed by a sight feed cup, and the main bearings by ring oilers which dip into an oil reservoir beneath the bearing.

The Otto engines are usually made with single cylinders placed horizontally. Several designs of the smaller sizes, from

1 to 3 horse-power, are made with vertical cylinders. They are suitable for small pumping stations, newspaper plants employing a cylinder press and three or four platens, ice cream manufacturers, and other industrial plants which require small, economical power producers. Otto vertical cylinder pumping engines are made in sizes from 3 to 150 horse-power, while

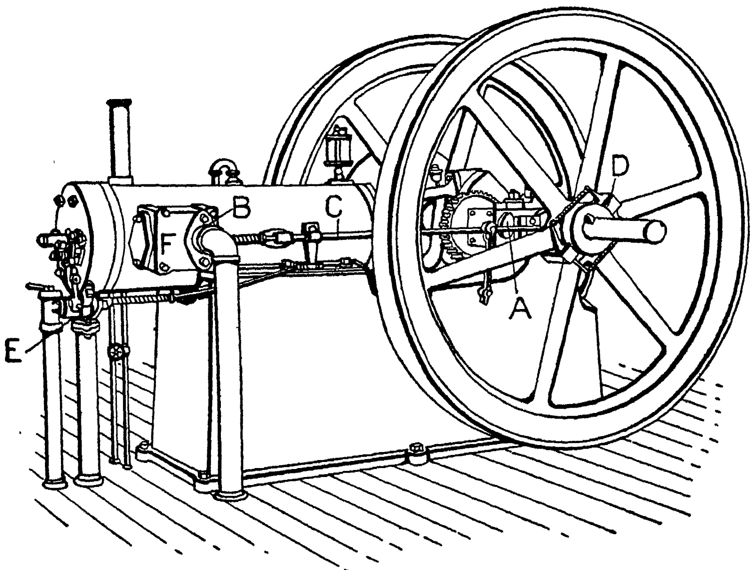

Fig. 57.—Fairbanks-Morse Horizontal Engine.
(Paragraph 194)

those of the regular horizontal type range from 4 to 200 horsepower.

194. **The Fairbanks-Morse.** These engines are of the four-cycle single acting type, but they are made in all sizes with either horizontal or vertical cylinders, the former usually of the single cylinder, and the latter of the multi-cylinder, type.

Fig. 57, gives a general view of a 60 horse-power horizontal engine, and *Fig.* 58, a view of the patent self-starter arrangement.

As shown by *Fig.* 57, the engine has two poppet valves both of which are protected by water jackets. A single cam, A, operates the exhaust valve, B, through a straight rod, C, carried

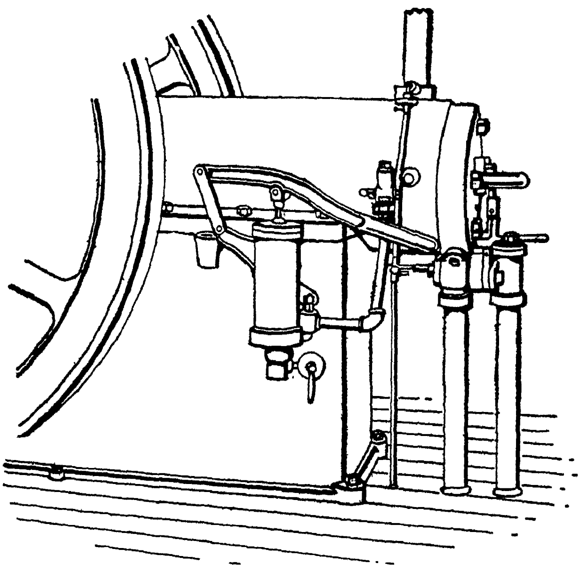

Fig. 58.—Fairbanks-Morse Self-starter.
(Paragraph 194)

in suitable guides, and represents practically all of the valve gear of the engine. The governor, D, is attached to the fly-wheel and acts directly upon the exhaust valve. This device relieves the engine from compression, and at the same time cuts off the supply of gas when not required. *Fig.* 57, also shows the position of the admission valve, E, and the arrangement of

the cylinder head. The exhaust chest, F, is attached to the cylinder by studs, and is therefore, capable of being removed at small cost whenever necessary. The connecting rod is adjustable at both ends, at the piston end by means of a screw and wedge, and at the crank end by means of bearing boxes of the marine type. Ignition is effected by an electric spark, but tube igniters are also provided.

The horizontal engines are equipped with the self-starter arrangement shown in *Fig.* 58. In starting, the detonator is charged and inserted in the fixture attached to the cylinder; the pump is then operated and a charge forced into the cylinder and ignited by the detonator or by a spark from an electric igniter. The resulting expansion has sufficient force to start the engine under about half load, without shock, a most essential feature in the management of a gas engine. With this arrangement, one man can start an engine of from 5 to 100 horse-power. The method in vogue with the vertical types differs from that of the horizontal in that the charging pump is not used on sizes below 12 horse-power. In those the starting is accomplished by means of a crank placed on the end of the crank shaft; this crank has a pawl which is engaged in a slot in the crank shaft, so that, when the handle is revolved in the regular direction of motion of the engine, sufficient speed is obtained, from a few turns, to effect an ignition which will run the engine away from the pawl of the starting crank, thus permitting its removal.

Engines of the same design, suitable for burning kerosene and the heavier grades of crude oil, are described in Chapter XX.

195. **The Foos.** All of the Foos engines are of the four-cycle, single cylinder, horizontal, single-acting type. Nearly

all the working parts are assembled on one side of the cylinder, thereby facilitating installation, and giving free access to the devices for regulating the speed, the fuel and air supply, the time of ignition, and for starting the engine.

Fig. 59, shows the valve gear side of the engine, and *Fig.* 60, a cross section through the cylinder and valve chambers.

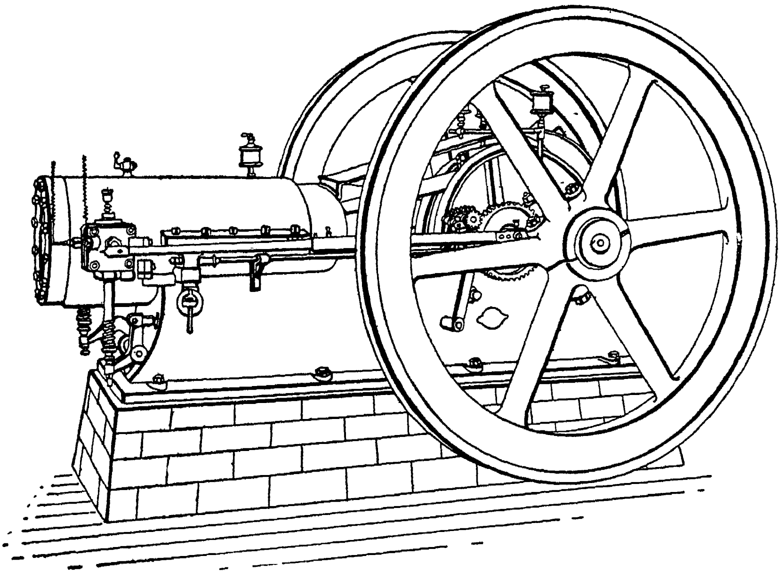

Fig. 59.—Foos Gas and Gasoline Engine.
Valve Gear Side.
(Paragraph 195)

The design is the same for all sizes, the cylinders being bolted to the beds by long ways which project from the sides. The water jacket is large and cast solid with the cylinder. It is closed at the end of the cylinder head, which is itself thoroughly water-jacketed, and is capable of removal so as to permit the clearing away of obstructions sufficiently large to interfere with the circulation.

Referring to *Fig.* 60, it will be noted, that the admission valve, A, and the exhaust valve, B, are placed in separate water-jacketed castings on opposite sides of the cylinder, and communicate by means of large ports with the combustion chamber, C. These valves are of the vertical poppet type, and are positive in their action. As the weight of the valve acts in the

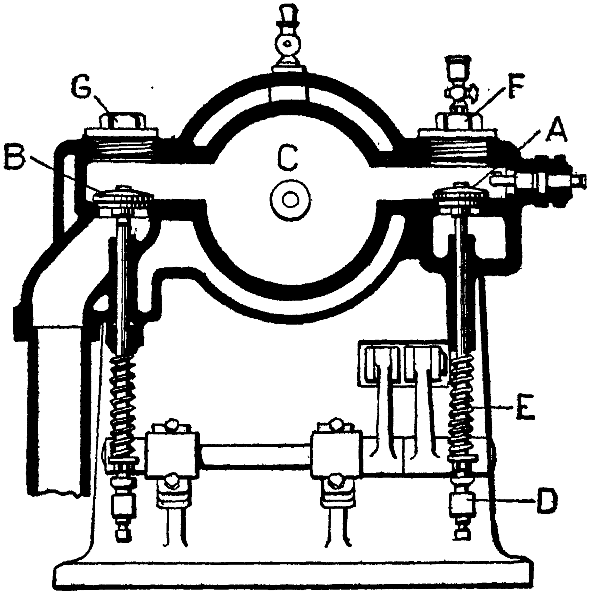

Fig. 60.—Foos Gas and Gasoline Engine.
Cross section through Cylinder and Valve Chambers.
(Paragraph 195)

direction of its motion it returns naturally to its seat and maintains a tight contact even without the aid of a spring.

Suction in the cylinder is not relied upon to open the admission valve; it being lifted positively by the lever, D, and closed by its own weight aided by the action of the strong spring, E. Although the valves are in separate removable boxes it is not

necessary to detach these boxes in order to remove the valves. The admission valve can be taken out by unscrewing the plug, F, and the exhaust valve by removal of the plug, G. The valves can be ground in when necessary by the use of an ordinary brace and bit.

The valve gear is operated through steel cams driven by machine cut gears; and by adjusting, with a common wrench, the screws carried by the lift lever, D, any wear or looseness in the valves may be quickly and effectively taken up.

The governor is of the centrifugal type. It is of simple and compact construction and regulates the supply of fuel by cutting out the charges beyond those required to maintain uniform speed.

The igniter is of the electric wipe-contact type, and is located in the admission chamber directly over the admission valve.

The engines are made in sizes from 2 to 80 horse-power, and self-starters are furnished with several different types ranging above 26 horse-power.

196. **The Wayne.** These engines are all of the four-cycle, single cylinder, horizontal, single-acting type, and are designed for using either gas or gasoline.

Fig. 61 shows a general view of the valve gear side of the engine; *Fig.* 62, a sectional plan through the cylinder and valve chambers; and *Fig.* 63, the valve gear mechanism and governor.

The cylinder is bolted to the engine frame, and is provided with a water jacket of ample proportions having large openings for the removal of lime, sand, or other deposits.

The cylinder head forms part of the combustion chamber and contains all the valves and the devices for starting and igniting.

The valves are of the poppet type and are operated by a rod and lever actuated by a single spring and cam.

The governor is of the centrifugal fly-ball type. It is geared to the cam shaft and controls the engine by cutting off or admitting the fuel supply according to the requirements of the load.

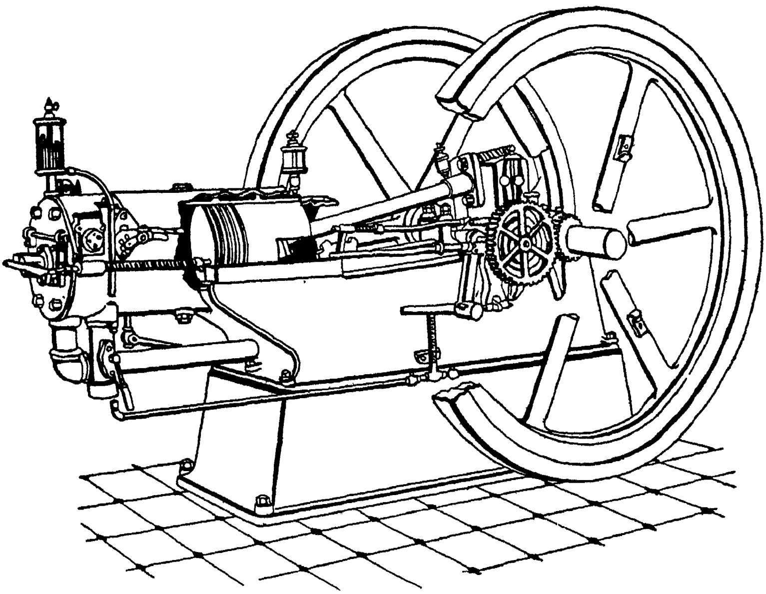

Fig. 61.—Wayne Gas and Gasoline Engine.
Valve Gear Side.
(Paragraph 196)

Referring to *Figs.* 62 and 63, this action may be described as follows: The valve rod, A, is operated by the cam, B, on a short secondary shaft, C, geared to the main shaft, D. When the action of this cam throws the rocker arm, E, to the left, it opens the exhaust valve, F; and when the valve rod is released by the cam, the spring, G, returns the rod and opens the gas

valve, H, delivering the fuel to the admission valve, I, which is opened directly into the chamber by atmospheric pressure. During a normal charging stroke, the valve rod is entirely released by the cam and holds the gas valve open by means of the spring, G, to the end of the stroke. The rod then releases the gas valve and takes an intermediate position during the compression and working strokes. At the end of the working stroke, the cam comes again into position and pushes the valve rod clear out, thus opening the exhaust valve.

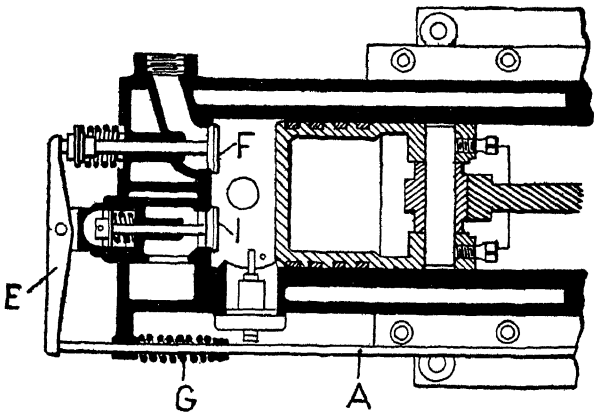

Fig. 62.—WAYNE ENGINE.
Sectional plan through Cylinder and Valve Chambers.
(Paragraph 196)

This is the cycle that conforms to normal speed; but, when the speed increases excessively, the governor lifts the end of a latch, J, which engages a lug on the rocker arm, K, thus holding the valve rod back and allowing the gas valve to remain closed so that air only enters into the cylinder through the admission valve.

Ignition is effected by electric spark, through a hammer-break igniter operated by a separate firing rod, L, which is actuated

by an individual cam, so that the blade, M, on the end of the firing rod engages an arm, N, on the spindle of the igniter. The release of the arm is affected by the movement of a triangular block, O, on the end of the firing rod, which rides up on the roller, P, and throws the end of the pick-blade above the end of the igniter arm.

These engines are built in sizes from 6 to 150 horse-power.

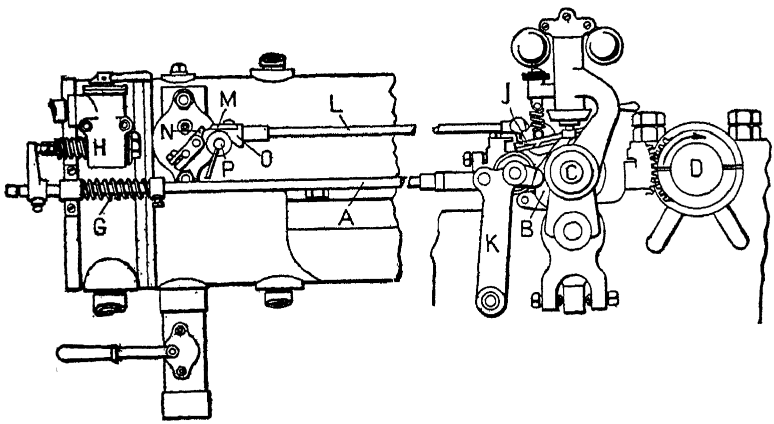

Fig. 63.—Wayne Engine, Valve Gear and Governor.
(Paragraph 196)

197. **The Model.** All of the Model gas and gasoline engines are of the four-cycle, single-cylinder, horizontal, single-acting type. One feature particularly noticeable in their design is the absence of a separate cylinder head, the cylinder and water jacket consisting of a single casting, in which the only openings in the water jacket are those for the water pipe connections.

The valves are of the poppet type with long stems which permit of their being raised squarely from their seats. They are placed in a small box entirely separate from the cylinder, and

are therefore capable of being renewed with the least possible expense.

Fig. 64, shows the valve gear side of the engine. For complete description of engine parts, see *Figs.* 51 and 52.

The governor is of the centrifugal type, and regulates the speed of the engine by cutting out the charges beyond those required to maintain uniform speed. It is of very simple construction. At normal speed, a dog holds the governor cam and prevents its action, but when the speed increases, the raising of the point of the dog releases the cam and allows the governor to act. As the amount of displacement necessary to release the cam is from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch, the governor is very sensitive, but in order to make it as much so as possible, and also to take up the wear, both cam and dog are provided with set screws and lock nuts for raising or lowering the point of contact. The speed of the engine can be increased or decreased by means of a screw which acts on the tension spring of the governor.

Ignition is effected by an electric spark obtained by means of a make-and-break igniter of very simple but effective construction, operated by an individual rod actuated by the main shaft through the valve gear mechanism. It is capable of being readily removed and replaced, whenever necessary, in a few moments, without interfering with any other part of the engine, and the time of ignition can be changed while the engine is in operation, without removing any part thereof, by means of a screw which lengthens or shortens the igniter rod.

These engines are built in sizes from 2 to 75 horse-power. The design is the same for all sizes, and the engines can be adapted for using kerosene and crude oils by the mere addition of a fuel tank, as the engine takes the oil directly into the cylinder, and, therefore, does not require a vaporizer. When

kerosene or crude oil is used the engine is operated for the first five minutes on gasoline, then the gasoline supply pipe is closed, and the oil turned on; no heating of the engine previous to starting being required.

198. **The Olds.** These engines are built in two classes known to the trade as Type A and Type G. Both types are

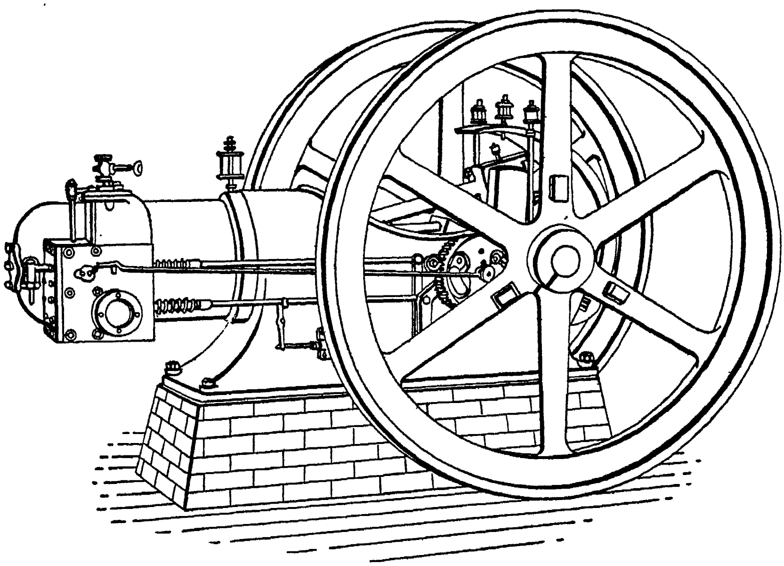

Fig. 64.—Model Gas and Gasoline Engine.
Valve Gear Side.
(Paragraph 197)

four-cycle, single cylinder, horizontal, and single-acting, but differ from each other in details of construction. As type A is the later product, and undoubtedly represents the best effort of the makers, its description will be sufficient in this connection.

Fig. 65, represents a sectional view of Type A; *Fig.* 66, the carburetter; and *Fig.* 67, the governor.

In the arrangement provided for the proper proportioning of the charge, the fuel comes to the mixer under a slight gravity head of about 3 inches, and, at each working stroke, a small amount is admitted by the opening of a needle valve, A, in the carburetter, *Fig.* 66, the lift of the valve being allowed to reg-

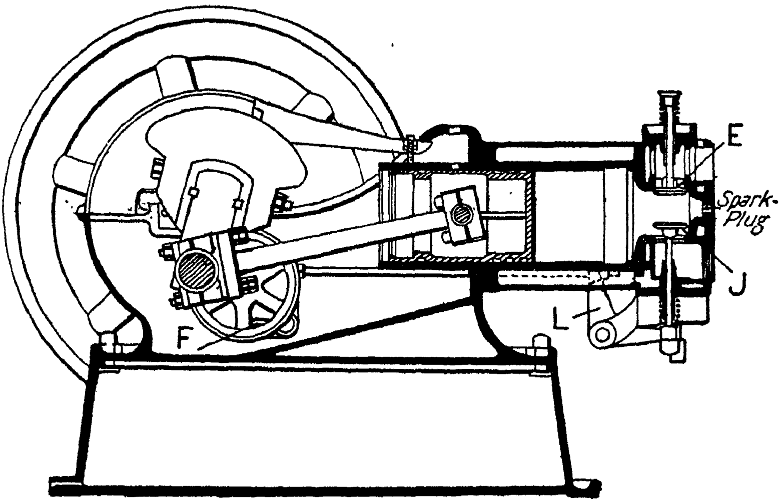

Fig. 65.—Olds Engine.
Longitudinal Section, Type A.
(Paragraph 198)

ulate itself, while the flow of gasoline is controlled by the screw needle valve, B, in the supply pipe. Air is admitted through an annular opening, C, around the gasoline jet, the blast serving to spray the fuel and thus form the explosive mixture. At very low speed, the force of the blast through the normal opening is not sufficient to spray the fuel satisfactorily. This is remedied by the provision of a movable washer, D, which is

pushed up against the air admission opening at starting, thus cutting down the area of that opening and increasing the velocity of the air passing through it. From the mixer, the charge is drawn into the cylinder through a spring-closed admission valve, E, *Fig.* 65, and there ignited by a jump-spark. The spark points of the igniter are placed in the center of the cylinder head and directly in the path of the incoming charge, so that not only are the points swept clean at every working

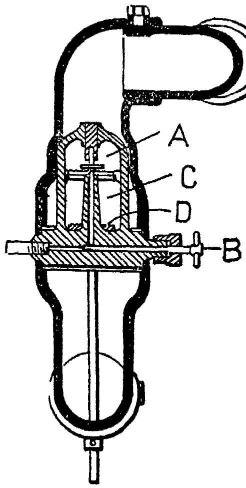

Fig. 66.—OLDS ENGINE.
Carburetter.

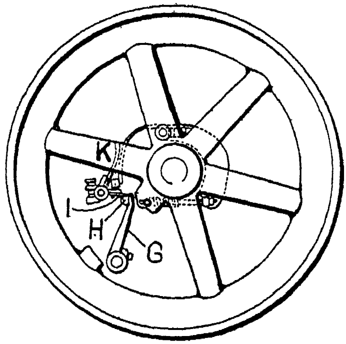

Fig. 67.—OLDS ENGINE.
Governor.

(Paragraph 198)

stroke, but they tend to inflame the charge uniformly in all directions. The electric current is derived from a dynamo, and the make-and-break mechanism of the igniter is mounted outside of the engine frame, on the lever which operates the exhaust valve. A depression on the operating cam drops the lever and brings the electrodes in contact, and the rise which immediately follows breaks the circuit.

The governor is of the centrifugal fly-ball type as shown in *Fig.* 67, and controls the speed of the engine by the hit-or-miss method. A rocker arm, F, *Fig.* 65, is placed below the main shaft and driven by a cam on a geared secondary shaft which makes one revolution for every two revolutions of the main shaft. The rocker shaft carries an arm, G, *Fig.* 67, on the end of which is a catch, H, which is engaged by a pawl, I, so that the exhaust valve, J, *Fig.* 65, is held open and causes the engine to miss an explosion whenever necessary. The pawl carries, at right angles to itself, the curved arm, K, *Fig.* 67, which is engaged, by a similar arm on the governor weight, while the engine is at or below normal speed; but, when the speed increases and the governor rises above the normal position, it fails to hold out the pawl, so that it engages the arm on the rocker shaft and prevents the operation of the valve. From the rocker shaft near the main shaft, a link rod drives a rocker arm, L, *Fig.* 65, located under the head of the cylinder. This rocker arm lifts the exhaust valve by means of a swinging bail. The rod which keeps the admission valve closed, during the period of an omitted explosion, passes up through the valve chest and acts on the valve by holding under the spring on the valve stem. The igniter electrodes are mounted one on the rocker shaft and the other on the engine frame.

All working parts are placed in the cylinder head and mixing chamber, thus making the cylinder as simple as possible, a mere interior barrel with flanges, surrounded by an outside barrel, the annulus between which forms the water jacket. The water jacket is packed at each end between the two barrels, and provided with an outlet for the water, the inlet for the water being in the cylinder head, which is a single casting making a ground joint with the cylinder. The cylinder head is divided into two compartments, one for ignition, provided with openings for the

admission and exhaust valves, and one for cooling water which passes into the jacket through annular openings near the circumference. The mixer consists of a separate casting bolted to one side of the cylinder head and containing the reservoir for gasoline, the regulating needle valve, and the operating needle valve.

In order to maintain a constant compression, the main bearing is made with the side farthest from the cylinder as a separate block having a double wedge on its back. Two wedge blocks drawn together by means of a bolt, operate to press the shaft constantly towards the cylinder, and thus take up the wear of the bearings on the side on which it occurs. A compression of 75 pounds gives the best result for a gasoline mixture.

These engines are made in sizes from 2 to 125 horse-power.

199. **The Weber.** These engines are of the four-cycle, single cylinder, horizontal, single-acting type. They are designed for using either gas or gasoline, and are proportioned throughout to withstand the severest service successfully.

Fig. 68, shows a side view of the engine, and *Fig.* 69, a partly sectional view of the mixer.

The valve gear is of simple design, all of its component parts being placed at the side of the cylinder near the cylinder head. The valves are of the poppet type, the exhaust valve being actuated by means of a rocker arm operated by a cam on the side shaft. The gasoline pump is bolted to the side of the engine frame, beneath the shaft, and is operated by a cam on the side shaft, the fuel being injected into the cylinder in the proper quantity and only as frequently as is required to maintain uniform speed.

The governor is of the centrifugal fly-ball type. It actuates a bell crank lever, the lower or longer arm of which is provided with a steel block which engages a corresponding block on the lever operated by the cam on the shaft, and which in turn actuates the plunger of the pump. When the speed increases

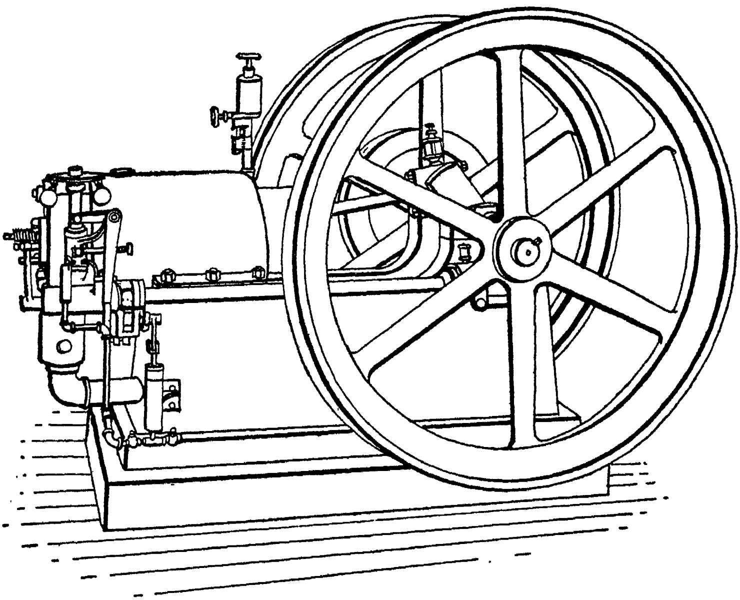

FIG. 68 —GAS AND GASOLINE ENGINE.
Valve Gear Side.
(Paragraph 199)

above the normal, the long arm is caused to swing slightly towards the right, engaging the lever which operates the pump plunger, and preventing the latter from rising, thus stopping the action of the pump. As the difference in the lengths of the arms of the bell crank is comparatively large, a slight movement of the governor is sufficient to bring the steel blocks either into or out of engagement, and thus permit a very close regulation.

When the fuel is gasoline, it is used in its natural state, without the intervention of any gasifying devices between the fuel supply and the cylinder. The gasoline is usually stored in a tank placed outside of the building occupied by the machinery, and direct connections are made with the engine by means of $\frac{1}{4}$ or $\frac{3}{8}$ inch piping.

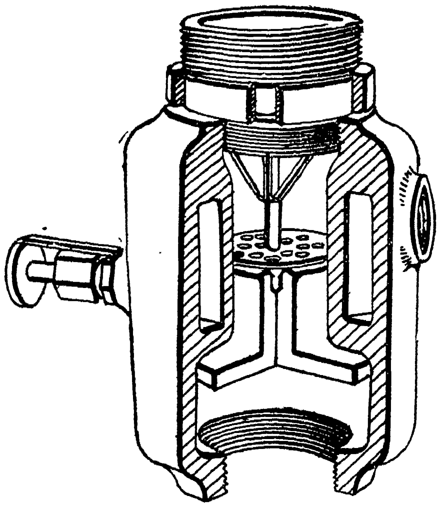

FIG. 69.—WEBER ENGINE CARBURETTER.
(Paragraph 199)

The mixer shown in *Fig.* 69, consists of a heavy iron casting which confines the injected gasoline within strong walls immediately after it leaves the pump, and thus prevents the occurrence of an explosion outside the cylinder.

The cylinder and valve chambers are provided with ample water jackets. Proper lubrication of all the important bearings is effected by sight feed oil cups, and a special oil cup is provided for the lubrication of the cylinder.

Ignition is effected either by hot tube or by electric igniter.

200. The White-Blakeslee. All of these engines are of the four-cycle, single cylinder, horizontal, single-acting type. They are built in massive proportions, and are well calculated to sustain sudden strains and stresses.

Fig. 70, gives a general view of the engine and shows the positions of the governor, valve gear mechanism, and igniter arrangement.

The speed of the engine is regulated by varying the volume of the charge by the action of a throttling governor operated from the side shaft by means of bevel gears.

The mixer, A, consists of a casting of irregular shape located directly under the cylinder, and connected with air supply pipe, B, leading from the sub-base, and the gasoline supply pipe, C, leading from the pump, D. Both of these connections are controlled by valves which require, under normal conditions of operation, merely to be opened to the proper positions as stated in the directions. In extremely cold weather, however, the air valve may be changed so as to thoroughly vaporize the gasoline mechanically, and without the application of heat. The butterfly valve, E, operated by the governor, is located at the upper end of the mixer with the admission valve, F, immediately above it and below the cylinder. By this arrangement, the charge is formed at the instant before it is required by the engine.

The governor is of the centrifugal fly-ball type and operates without the aid of springs.

The igniter mechanism is arranged so as to bring the electrodes into contact for a very short period of time, thus giving an effective spark from a very small amount of current.

201. The Burger. Although these gas and gasoline engines are of the regular four-cycle, single cylinder, horizontal single-

acting type, they possess a characteristic automatic action due to a governor which is a modification of the Rites inertia governor.

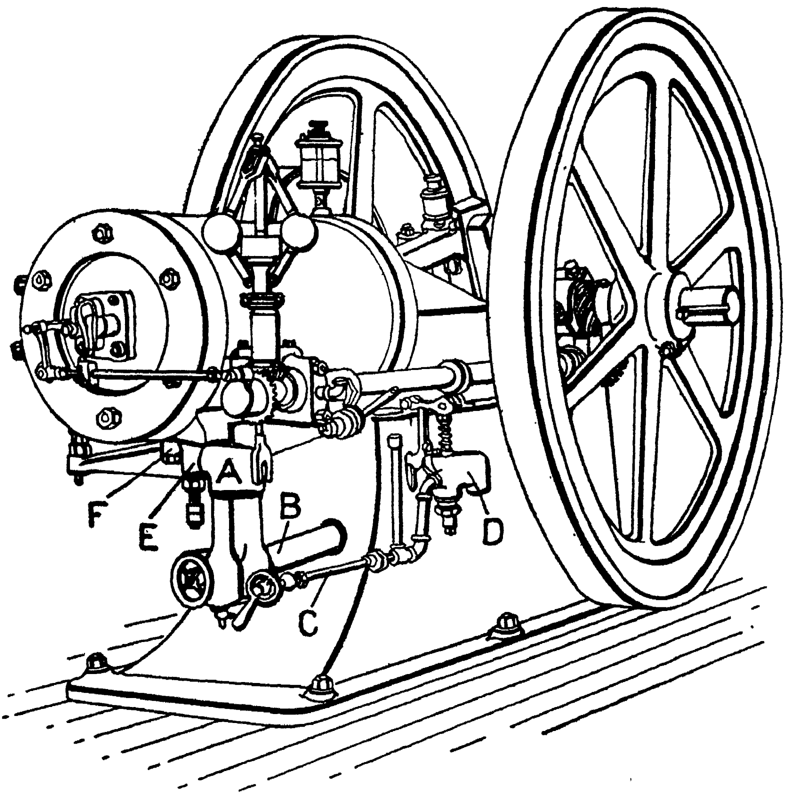

FIG. 70.—WHITE-BLAKESLEE ENGINE.
(Paragraph 200)

Fig. 71, shows the valve gear side of the engine, and *Fig.* 72, a horizontal section through the cylinder and valve chambers.

Referring to *Fig.* 71, the governing mechanism and its action may be briefly described as follows: A pinion, A, rotatable on the end of the main shaft, carries a wrist pin which is connected to an eccentric rod, B. The sector of the governor, C, meshes with this pinion and by rotation changes the position of the wrist pin with reference to the crank. *Fig.* 72, shows that the governor valve, D, is cylindrical and provided with ports which register with corresponding ports in the valve casing. These ports are formed in sets, each one containing four ports. The two sets to the right are air ports, and the two to the left are gas ports. The admission valve, E, projects into the cylinder and carries the gas valve, F, on the outer end of its stem.

The suction stroke opens the admission valve and with it the gas valve, and allows the gas to pass from the outer chamber, G, to the inner chamber, H, and thence through the gas ports in the governor valve into the cylinder; the respective amounts of air and gas admitted through the ports being determined by the length of time during which the ports remain open. If the engine is running on quarter-load, the ports will remain wide open during one-fourth of the piston stroke, and if on half-load, during one-half the stroke. The stroke of the valve, however, is always the same; therefore, in order to obtain the automatic effect, it is necessary to rotate the pinion so as to change the position of the wrist pin relative to the crank.

The exhaust valve, I, is of the poppet type and held firmly against its seat by the helical spring, J. The two to one gear which operates this valve through the side shaft, is mounted on the main shaft between the engine bed and the cheek of the crank, the larger gear carrying the exhaust and igniter cams.

Ignition is effected by means of an electric spark from a movable igniter plug, K, *Fig.* 71, fitted into a hole communicat-

ing with the upper part of the cylinder, the current being derived from a battery or from a dynamo attachment driven by the engine itself.

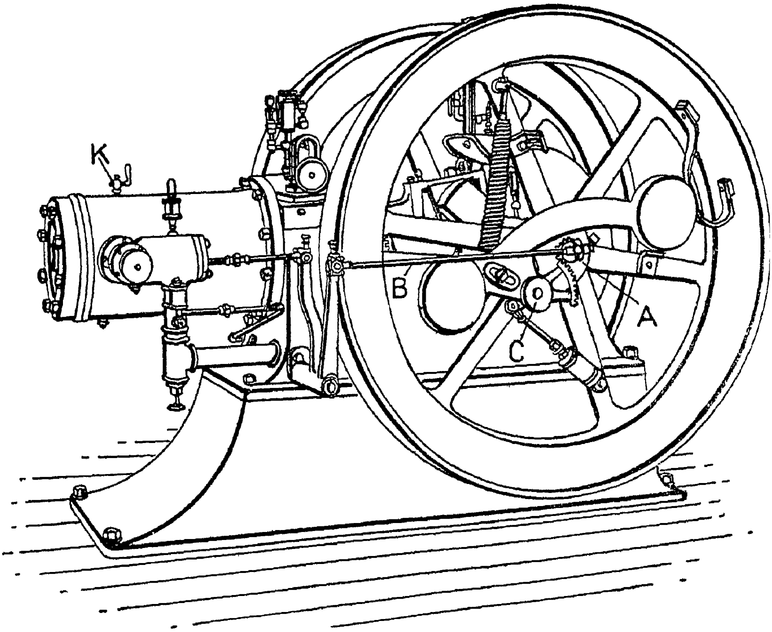

FIG. 71.—BURGER ENGINE.
Valve Gear Side.
(Paragraph 201)

A type of engine governed by the hit-or-miss method with suitably arranged gas and air, and gasoline valves, is also made by the same company.

202. **The American Crossley.** This engine is similar in all particulars of design, material, and workmanship, to the English Crossley engine, but is manufactured in the United States.

It is of the four-cycle, horizontal, single-acting type, but it is built in single cylinder, double cylinder, and four cylinder units of from 50 to 1,400 rated horse-power. Its details incorporate an experience of over thirty years, Messrs. Crossley having constructed the first commercially successful gas engine in 1876.

Fig. 73, shows a side elevation of the *vis-a-vis* double cylinder engine, and *Fig.* 74, a longitudinal section through the

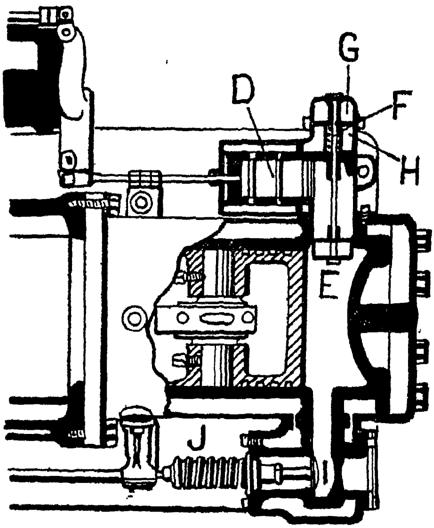

FIG. 72.—BURGER ENGINE.
Sectional View of Valve Chambers.
(Paragraph 201)

cylinders. The crank shaft has a center crank, A, and the two connecting rods, B and C, work on one crank pin, D, the rod, C, having a single box end and the rod, B, a forked end, the two boxes of which work on either side of the box of C, The main bearings are carried in the side frames, E, the ends of which are bolted to the cylinders. A steel crank pit, F, is

located between the side frames and serves to receive the waste oil, while the top is surmounted by a sheet-steel oil guard, G. The crosshead pins, H, are pressed in the connecting rods and work in adjustable bearings in the pistons. The pistons are water-cooled and are also provided with slippers, K, an important feature rarely found in single-acting engines. The main cylinder casting, L, which comprises the water jacket, is provided with extensions and flanges, M, on both sides, by which it is bolted to the side frames. The bottom of the cylinder has a foot, N, which is held down by foundation bolts. The working cylinder proper consists of a liner, O, circumferentially ribbed on the end exposed to the high initial temperatures and pressures, thus providing great strength and ample cooling surface. The cylinder head, P, is hollow and contains the admission and exhaust valves, the latter being inclosed in an independent water-cooled casting, Q, bolted to the bottom of the cylinder.

The valve gear is driven from the main shaft by means of spiral gears and the side shaft, R, the governor being driven in a similar manner by the side shaft, S.

Under this arrangement, the operation of the valve gear and governor mechanism at each end of the engine is as follows: The air and gas enter the mixing chamber, T, through the proportioning valve, the air entering the mixing chamber direct and the gas entering through a gas valve located at, V. From the mixing chamber, the air and gas pass to a cut-off valve and an admission valve located at W. The admission valve is opened by a cam on the secondary shaft, R, through a modified bell crank, X. The cut-off valve is of the multi-ported type and is operated independently of the admission valve by means of a rocker arm which also receives its motion from the secondary shaft, R.

When the load is constant, the cut-off takes place at the same point in each suction stroke, but when the load varies, the altered speed of the governor will move the rod, 1, by means of the rack, 2, so that a pinion will turn a screw which will move the rod attached to the rocker arm in and out, thus changing the position of the fulcrum of the latter and altering the point of cut-off.

This method of governing controls the speed of the engine throughout the ordinary range of loads, but when the load becomes light enough to make this throttling method uneconomical, the engine automatically changes over to the hit-or-miss method.

All of the engines described in this chapter are built in satisfactory types for application to most purposes for which power is required. Owing to the greatly superior fuel economy of the small gas engine over the small steam engine, the former is ideal for purposes of public utilities in connection with small urban or semi-rural localities, more especially those where coal is dear. For most of the applications of small stationary prime movers, gas engines may be satisfactorily installed.

They may be combined with gear-driven multiple well pumps for supplying small waterworks; with exhausters or pumps for drawing natural gas from deep-lying strata after the initial rock pressure has disappeared; or they may be directly coupled to centrifugal pumps in connection with irrigation or reclamation schemes, or for emptying graving docks.

Gas engines are used in large numbers to drive dynamos for electric light or power, either directly connected, or through a belt or rope drive. In the former case, it is necessary to employ multi-cylinder units to promote the necessary steady turning impulse and reduce the "winking" of the light occasioned

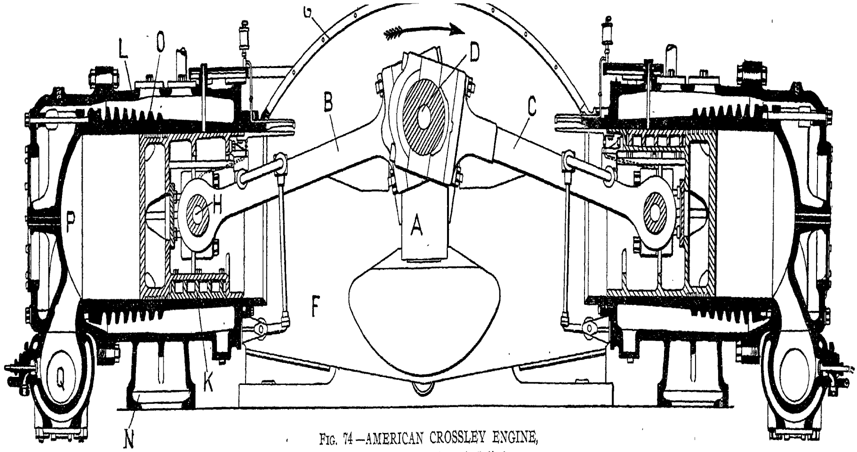

FIG. 74—AMERICAN CROSSLEY ENGINE,
Longitudinal Section through Cylinders.
(Paragraph 202)

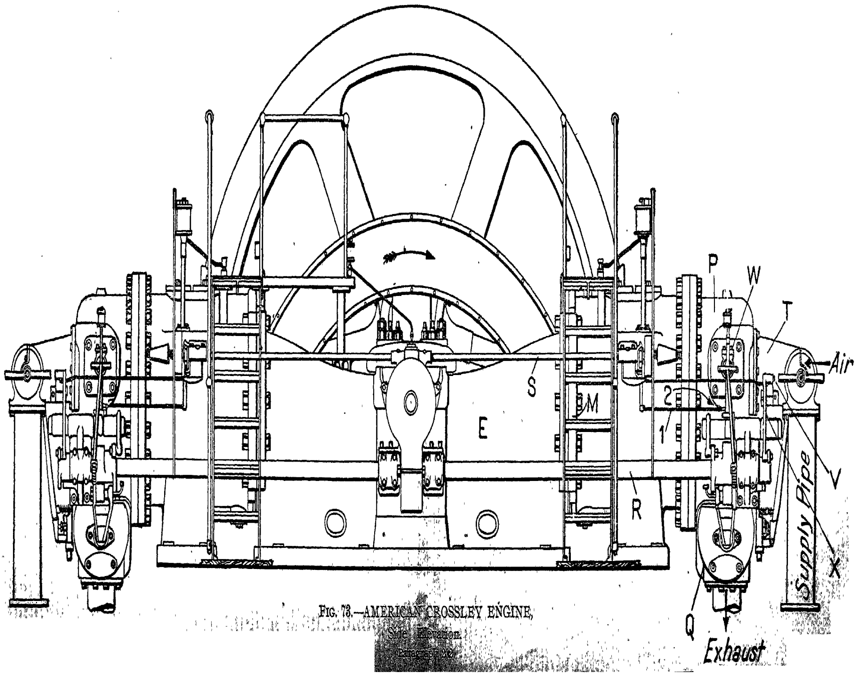

FIG. 73.—AMERICAN CROSSLEY ENGINE,
Side Elevation.
(Paragraph 202)

by the explosion. With the latter arrangement, the slight slip of the belt may lessen irregularities.

For factories and shipyards, gas engines are very economical and convenient prime movers. A small engine may be fitted to each line of shafting or to each small department, rendering it unnecessary to run the whole of the plant when overtime is being worked. This would be especially valuable, say, where cylinder boring was being carried on, as the boring shop frequently has to run continuously, taking the finishing cuts through a cylinder. A separate gas engine may also drive the blower for the foundry cupola, making it unnecessary to maintain steam after the other departments have closed down. In each case, the small gas engine requires far less attention than the steam engine which it would replace, besides costing much less for fuel, and being far cleaner than any boiler-fed installation can ever be.

Another development consists in mounting an engine upon a platform on wheels, for use either as a portable or traction engine. For these purposes, however, it is usual to adapt the gas engine to the consumption of kerosene or gasoline, for very obvious reasons.

Applications of internal combustion engines to many purposes are described in subsequent chapters.

CHAPTER XVI.

FOUR-CYCLE VERTICAL ENGINES.

203. Vertical, Single-Acting Engines. Engines thus defined are built by the various manufacturers in single-cylinder, double-cylinder, or multi-cylinder types. The single-cylinder engines are usually made in sizes ranging from 1 to 15 horse-power, the double-cylinder from 15 to 50 horse-power, and the multi-cylinder from 50 to about 300 horse-power.

In general construction, the various makes resemble each other very closely. They are nearly all of the inclosed crank-case type, differing from each other mainly in the mechanical details of their working parts.

The machines described in this chapter are some of the most successful engines of this type, and have been here selected chiefly for the purpose of illustrating a few of the many possible arrangements under this style of construction.

204. The Walrath. The Walrath engines are built in one, two, and three cylinder units, of the vertical inclosed crank-case type.

Fig. 75, shows a two-cylinder direct-connected unit of 50 horse-power especially adapted for electric lighting, where close speed regulation is essential. Units developing more than 50 and up to 150 horse-power are usually built with three cylinders. *Fig.* 76, is a vertical cross-section through one of the cylinders showing the general construction of the cylinder, crank-case, piston, etc., and the positions of the various valves and actuating levers.

A—Water Jacket; B—Crosshead oil-box; C—Igniter; D—Valve Rocker; E—Valve Rocker-Arm; F—Exhaust Valve; G—Exhaust Manifold; H—Water Outlet; J—Exhaust Pot;

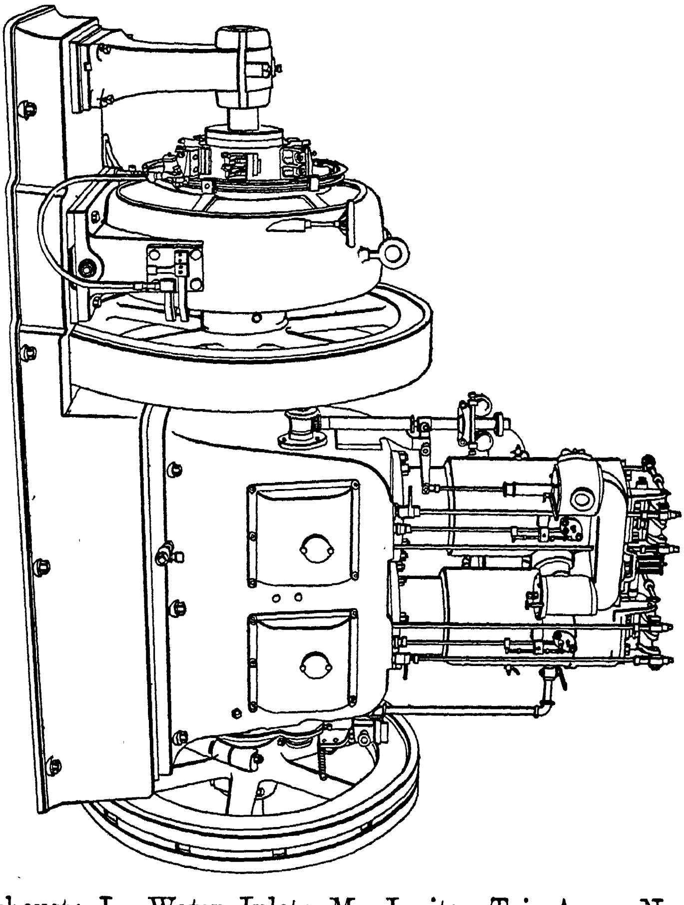

FIG. 75.—WALRATH ENGINE, 50 HORSE-POWER. Two Cylinder Unit. (Paragraph 204.)

K—Exhaust; L—Water Inlet; M—Igniter Trip-Arm; N—Radius Arm; O—Cam Shaft spur-wheel; P—Intermediate spur-wheel; Q—Rear Cover-Plate; R—Igniter Trip Rod.

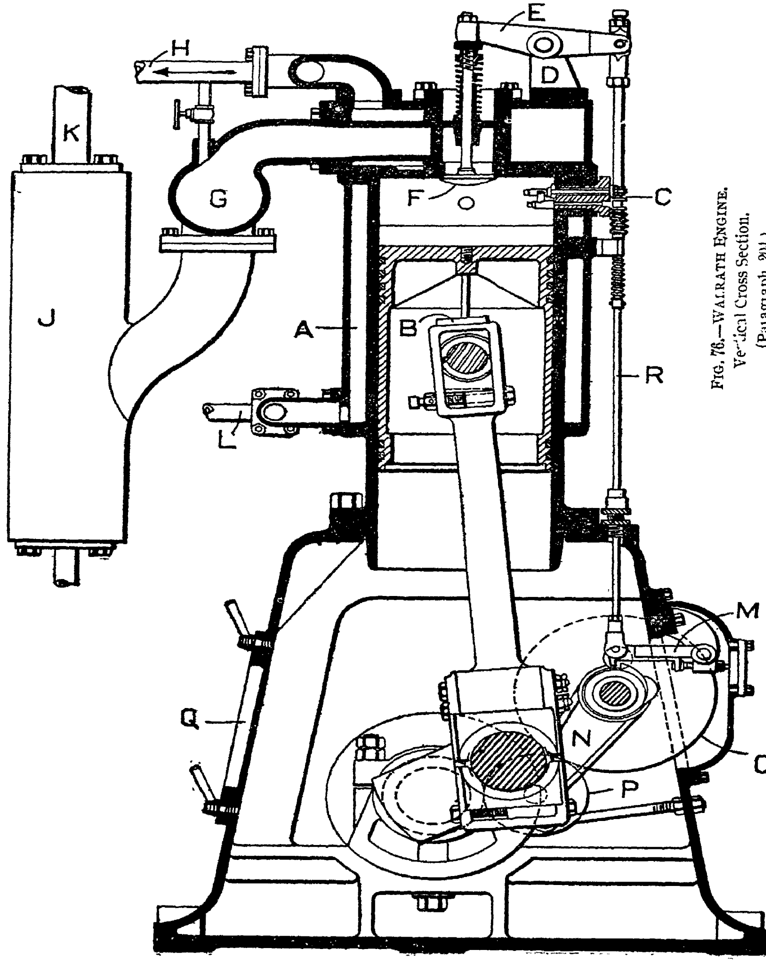

FIG. 76.—WALRATH ENGINE.
Vertical Cross Section.
(Paragraph 204.)

In general construction, the three styles are practically identical, differing only in the number and size of the cylinders. The base or crank-case is cast in one piece and bored to receive the cylinders, main and valve-gear bearings, the latter being removable and adjustable for wear. The closed crank-case provides automatic lubrication for all of the internal working parts, the connecting rod dipping into the oil contained in the bottom of the frame and thus splashing a copious supply into the cylinders and main bearings. Oil cups are also placed on the outside of the framing, the oil being led through suitable pipes to all the bearings, which tends to maintain the required level of oil in the base.

All of the engines work on the four-cycle principle, the valve mechanism consisting of a simple shaft driven by means of three spur-wheels, which, together with those employed for driving the governor, are the only ones required to operate the several cylinders.

The governor is of the fly-ball type and is placed at the end of the engine frame. It operates a piston valve, which regulates the amount of explosive mixture for each impulse, admitting just enough to maintain uniform speed under all variations of load, and giving an impulse every second revolution of the crank for the single-cylinder engine, every revolution for the two-cylinder, and every two-thirds revolution for the three-cylinder engine, irrespective of the load.

The igniter consists of a casting which holds two electrodes, the stationary electrode being insulated in the plug, while the movable electrode is operated through the vertical igniter stems by a cam on the valve gear shaft. The contact points are of platinum wire set in steel and capable of being removed without disturbing the electrodes in the plug. The entire igniter

arrangement is secured in place by two studs and may be quickly removed without disturbing the other parts of the machine.

These engines are capable of using any kind of fuel, natural or manufactured, such as producer gas, gasoline, distillate, kerosene, or crude oil.

The admission and exhaust valves are of the poppet type, and are operated mechanically. On all engines above, and including, 10 horse-power, double-cylinder type, both valves are placed in cages fitted into the cylinder head and provided with ground joints. As these valves extend through the head, it is possible to do away with any pockets or recesses in the combustion chamber, and thus facilitate the re-grinding of the valves whenever necessary.

Each cylinder consists of a separate casting, free to expand without any tendency to get out of alignment. They are completely water-jacketed, successfully keeping the temperature low enough to insure copious lubrication at all times.

The reciprocating parts are carefully counterbalanced, the balance-weights being attached to the shaft instead of being cast in the fly-wheels. The length of the connecting rod is equal to three times the length of the piston stroke, and each end is fitted with gun metal brasses which are capable of being readily adjusted for taking up wear.

All engines above 20 horse-power are provided with a starting device, consisting of an air compressor and tank. The starting valve is a simple piston-valve operated by a cam and suitable auxiliary parts, which, at the proper time, make communication with the air tank and transmit the pressure to the engine. The same valve then opens the port leading to the atmosphere and exhausts the cylinder of air. This action con-

tinues until an explosion occurs, after which the air is shut off and the engine is allowed to attain its proper speed on the energy derived from its own fuel.

The engines of the belted type range from 2 to 300 horsepower units, and those of the direct-connected type range from 8 to 300 horse-power units.

205. **The Nash.** The Nash gas and gasoline engines are all of the four-cycle type, and their proportions appear to have been very carefully worked out, with a view to the attainment of reliability and durability, the bearing pins, crosshead pins, rollers, cams, and other similar working parts being made of steel, hardened and ground to the proper size.

Fig. 77, is a vertical transverse cross-section through one of the cylinders, and *Fig.* 78, a similar cross-section longitudinally through the crank shaft.

It will be noted that the barrels and heads of the cylinders are completely water-jacketed, with all passages large enough to provide a sufficient quantity of water for the effectual cooling of the cylinder.

The pistons are of the usual trunk type, and the connecting rods are of sufficient length to insure only slight wear, even after long-continued working of either the piston or the cylinder.

The crank shaft is in one piece of forged open-hearth steel cut from the solid. It is machine-finished all over, and runs in adjustable gun metal bearings so arranged that each crank is provided with a journal on either side. The larger engines are fitted with pillow-block brasses which can be easily removed for examination and adjustment whenever necessary. These brasses are made of phosphor bronze, accurately turned, and the bearings hand-scraped to fit them. The two brasses

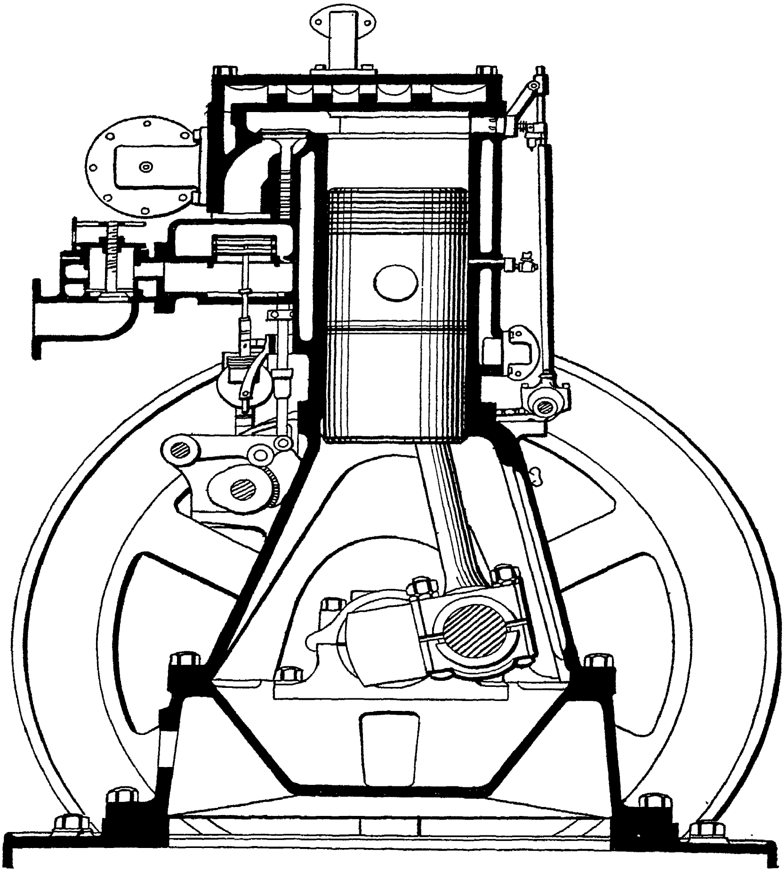

FIG. 77.—NASH ENGINE.
Vertical Cross Section.

do not quite complete the circle, and the blank space thus formed on each side is filled with thin sheet steel liners. When it is desirable to take up wear, the cap nuts are taken off, the cap and brasses removed, and the shaft raised a trifle so as to allow the lower brass to be turned around the shaft and then lifted out. The liners or shims permit of taking up wear whenever necessary.

The connecting rods are also forged from open-hearth steel, the crank end being of the marine type with adjustable steps of a special hard bronze, the end of the rod being spread to receive the lower brass, while the upper brass and cap are held in place by bolts at each side.

The valves and the entire valve-lifting mechanism are located on the working side of the engine, thus permitting convenient access to all the exposed working parts. The valves are of the poppet type, and as the cylinder heads contain no working parts, the removal of the covers, whenever necessary, exposes the pistons and valves for inspection and cleaning.

A single cam shaft driven by a pair of spur gears operates all the valves through the medium of levers and rollers. Each cylinder has its own admission, gas, and exhaust valves actuated by its individual cam, roller, and lever; each also having a gas valve with a pawl engaging a toe carried on the admission-valve stem. By this arrangement, both of these valves open together for the purpose of admitting a charge, or else the governor acts, disconnecting the pawl, so that the gas valve remains closed and no charge is admitted until the normal speed has been restored.

The exhaust valve is located immediately behind the admission valve, and the exhaust connection appears behind the cylinder above the gas valve. Just below this is located the opening

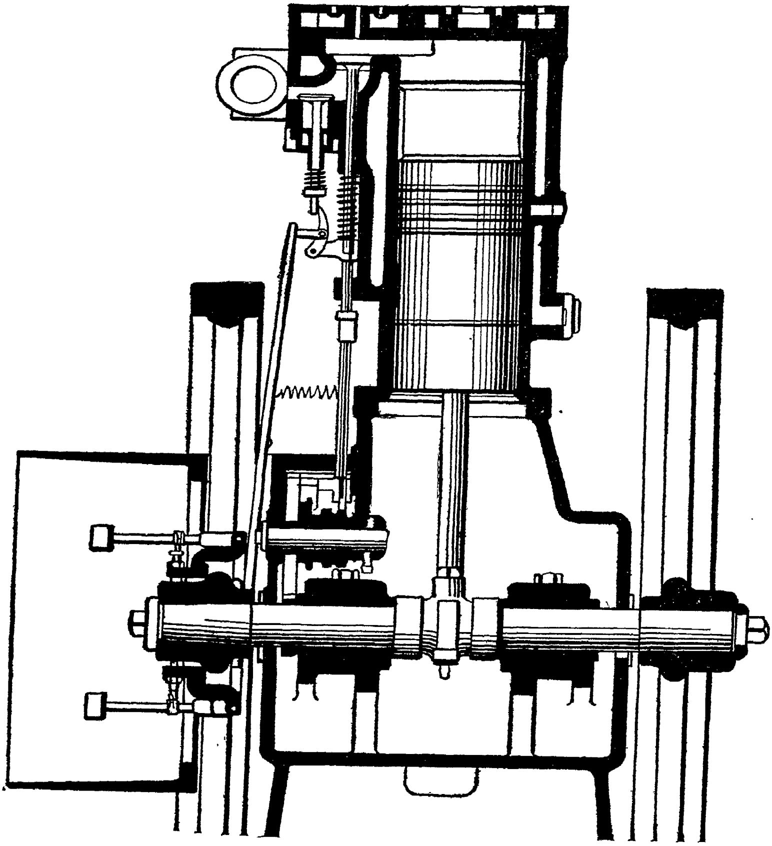

Fig. 78.—Nash Engine.
Vertical Longitudinal Section.
(Paragraph 205.)

by which the gas enters the mixing chamber, and, surrounding the upper part of the gas connection, is an annular opening through which the air passes and mixes with the entering gas to form the charge.

In the single-cylinder engine, the governor is a simple form of shaft governor. In the multi-cylinder engines, a special fly-ball governor operates by the method of missed ignitions. This governor does not operate the gas valves directly, but simply indicates by the position of a lever when the valves shall open or remain closed. Each cylinder is governed independently of the others.

When the throttling governor is employed, it acts on the common throttling principle by which a greater or lesser quantity of gas is admitted to the mixing chamber. The valve is actuated once during each cycle of each cylinder, but the quantity of explosive mixture is controlled by the action of the governor, the time of release of the valve and its fall determining the quantity of gas admitted to the cylinder.

Ignition is effected either by hot tube or electric spark. The hot tube is made of a special alloy of great durability and is heated by a Bunsen burner. The electric igniter can be operated from a battery, from an ordinary lighting circuit, or by means of a small generator attached to and operated by the engine itself. The electric igniter is secured in place at the top of the cylinder by two bolts, by loosening which, it can be readily removed whenever it becomes necessary to brighten the points which extend into the clearance space.

The single-cylinder engines range in size from 3 to 10 horse-power; the two-cylinder from 15 to 30 horse-power; and the three-cylinder machines from 40 to 150 horse-power.

206. The Westinghouse. The Westinghouse gas engines

are best known by those of the single-acting, vertical type, built in one, two, or three cylinder units. Recently, however, the manufacturers have developed a double-acting type which is specially adapted for central stations requiring generating units of high power. The double acting-type is not built in sizes below 200 horse-power, but continues the line of engine capacities beyond the present limit of the single-acting type so that the power units available in the two types range from 10 to 4,000 horse-power rated capacity.

The rating of these engines is based in all cases upon the brake horse-power. All engines are carefully tested previous to shipment, and are subjected to a series of performance tests, the records of which are always kept on file. The pressures usually carried with natural gas are approximately 350 pounds explosion pressure, 120 pounds compression pressure, and 30 pounds exhaust pressure. All types operate on the four-cycle principle. The verticle engines are built in two general styles; (a) two-cylinder for gas or gasoline; (b) three-cylinders in sizes up to 300 horse-power. For the smaller powers two-cylinder engines are used, and for medium powers the three-cylinder type, which is readily adaptable for generator driving, either continuous or alternating current, singly or in parallel.

The double-acting type will be found described in paragraph 213.

In the present paragraph *Fig.* 79, shows a general view of a three-cylinder engine, and *Fig.* 80, a cross-section through one of the cylinders.

The governing is effected by varying the quantity of the explosive mixture admitted to the cylinder, in proportion to the load on the engine, thus obviating the occurrence of idle strokes. The governor is mounted at the end of the engine on a short

vertical spindle geared to the main shaft. It is of the fly-ball type with knife edges and roller contacts.

These engines employ fly wheels of moderate weight, and speed control is accomplished within any desired limits by means of the governor. In the case of alternating-current generators operated in parallel, the system of governing employed,

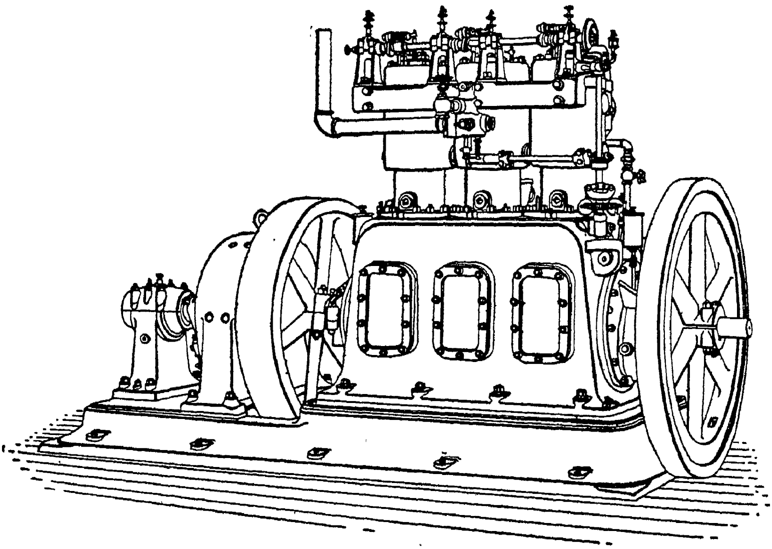

FIG. 79.—WESTINGHOUSE ENGINE.
Three-Cylinder Unit, 300 Horse-power.
(Paragraph 206.)

together with the multi-cylinder design of the engines, appears to give very satisfactory results in systems of low frequency, while for higher frequency and other special cases, a special type of coupling is provided, which gives a limited amount of flexibility to the engine generator drive.

The method of ignition ~~in all types~~ is by electric spark at

either high or low voltage, as may be desired. In plants where lighting current is available, the current can be taken directly from the mains and passed through incandescent pilot lamps, both for the purpose of limiting the current to the amount required and for indicating the continuity of the supply.

The most conspicuous features of the single acting type are the housed cranks, trunk pistons, roller-and-cam valve movement, adjustable and concentric journals, built-up cranks, and compressed-air starting devices.

Referring to *Fig.* 80, it will be noted that all the valve movements are accomplished by the single cam shaft, A, mounted within the housing. It is driven by a single reduction gearing directly from the main shaft, and upon it are mounted two sets of cams, one for operating the exhaust valve, and the other for operating the admission valve and the igniter. In each cylinder, a single cam is employed to operate both the admission valve and the igniter. The exhaust mechanism includes an auxiliary cam of opposite throw mounted loosely at the side of the main exhaust cam. This cam is thrown into engagement when the engine is started, and opens the valve at each stroke. The compressed air for starting is then admitted to one cylinder by the action of a special double-throw cam mounted outside the casing on the end of the cam-shaft so that this cylinder is allowed to operate temporarily as an air motor. During this operation, both the admission valve and the igniter of this cylinder are cut out of service by means of a clutch which is automatically operated by the compressed air system.

Fig. 80, also shows that all the working parts, both valves, and igniters, are contained in the cylinder casting, while the head is a plain cylinder cover cored out for circulating water.

A prominent feature of the design is the relative location of the admission valve, B, and the exhaust valve, D. These valves

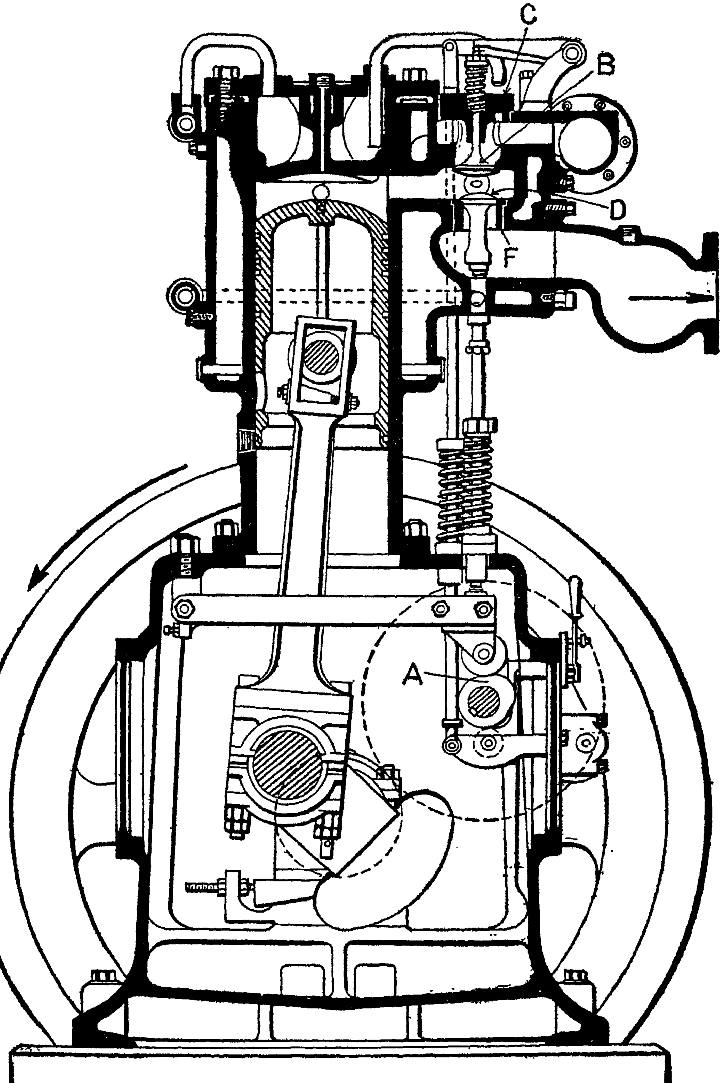

FIG. 80.—WESTINGHOUSE VERTICAL ENGINE.
Cross Section through Cylinder and Valve Chambers.
(Paragraphs 60, 206.)

seat vertically in opposite directions, are held in place by special springs, and are removable through the same opening in the casting. The admission valve is mounted in a bonnet, C, and may be removed in its entirety without dismantling, thus leaving room for taking out the exhaust valve, or its seat, F, if necessary. This arrangement tends to reduce the working temperature of the exhaust valve by causing the cool entering mixture to flow directly across the valve head. These conditions make it possible to use dry valves on comparatively large engines, but water-cooled valves are employed on all engines above 125 horse-power, and also in engines below this size when they are used for special purposes. The valves are of forged steel and are bored throughout the length of their stems, for the reception of a small copper water-tube through which the circulating water is conducted to the valve head, where it is discharged into a recess formed within the enlarged part of the valve, returning through the annular space between the tube and the spindle bore. In locations where cooling water is obtained from artesian wells, the valves used are of special design, made of cast iron.

The igniter is of the usual make-and-break type. It is removable in one piece in the form of a plug, and is operated by a vertical rod from the cam-shaft.

The mixing valves are of two forms, according to the character of the fuel gas. With natural or illuminating gas, quite free from solid or viscous impurities, a two-piece piston valve is employed, the vertical movements of which are directly controlled by the governor, so as to increase or decrease the port opening of each section in proportion to the load on the engine. With producer gas or other lean gases (such as blast furnace gas), a double-beat poppet valve is employed, and the proper

proportion of gas to air is secured by independent plug valves, each of which has graduated ports.

207. **The Meriam-Abbott.** In general construction, these engines are of the double-cylinder, vertical type, the cylinders working on the four-cycle principle. A transmission gearing is employed consisting of a vertical shaft, located at the rear of the engine midway between the cylinders, driving the secondary shaft by means of two to one bevel wheels. This secondary shaft is centrally located above the cylinder heads and carries both the valve cams and the igniter mechanism.

The four poppet valves—two for admission and two for exhaust—necessary for the operation of a double-cylinder engine, are located in a single head casting and open directly downward into the clearance space. By this form of construction, side pockets in the compression space are avoided and the amount of cooling surface reduced to a minimum.

Fig. 81, shows a 35 horse-power engine ready for mounting as a power generator, or to be directly connected to any standard make of electric generator of 20 kilowatts capacity. *Fig.* 82, shows the general arrangement of the system of ignition, the peculiar feature of which is the making and breaking of the primary circuit under a bath of oil.

In this system of ignition, the jump-spark method is employed, but there is no vibrator on the coil. The details of the device as shown in *Fig.* 82, consist of an oil cup, A, adjustable in the insulated sleeve, B, the tapered hole in the cup being capable of receiving an easily renewed taper pin. Contact is made between this pin and a spring rigidly fastened to the supporting framework, the entire arrangement being adjustable around its axis for the purpose of changing the time of ignition. The insulated terminals, C and D, in conjunction with the

rotating pin, E, serve to ground each cylinder alternately, thus permitting the use of a single coil and a single contact maker.

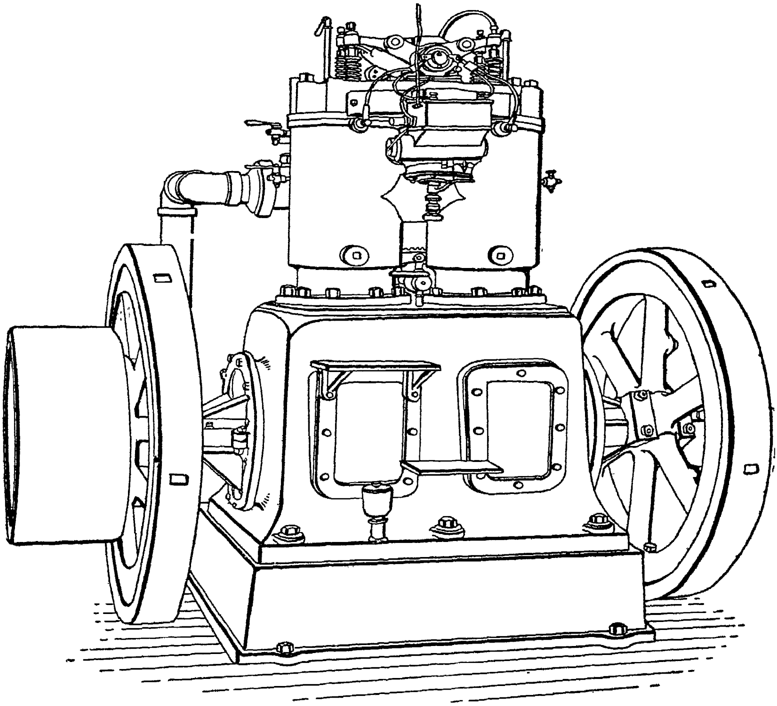

FIG. 81.—MERIAM-ABBOTT ENGINE.
Two-Cylinder Unit, 35 Horse-Power.
(Paragraph 207)

This system requires more current than the other forms of electric ignition, but is found to be very satisfactory for high-

*

duty service. Spark gaps are used at the plug terminals so that the spark is in sight while the engine is in operation. The only wearing part is between the two copper pins, and the wear on these can be readily taken up by adjusting the cup, A. No platinum is used in the system, and the cost of maintenance is very slight.

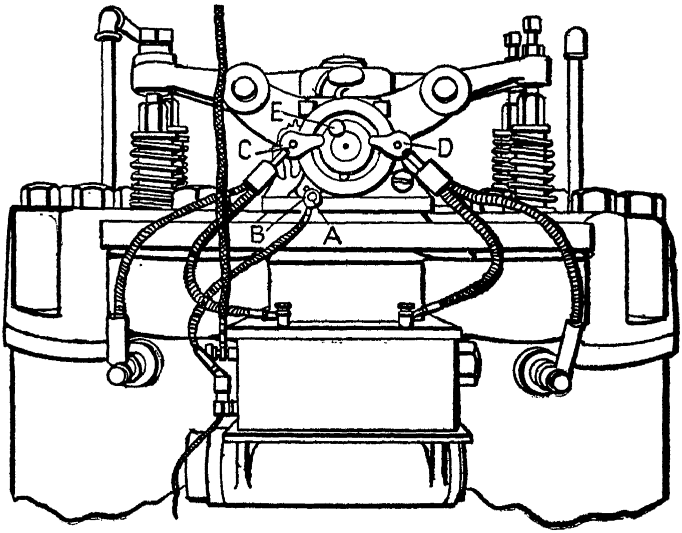

FIG. 82.—MERIAM-ABBOTT ENGINE.
System of Ignition.
(Paragraph 207.)

Another characteristic feature of this engine is the connecting rod which automatically adjusts itself for wear, by means of spring washers on the bolts, thus eliminating the necessity of taking it up from time to time, and insuring continuous running without knocking.

Compressed-air starters are used on all engines of 18 horsepower and over.

As has been stated, the primary electric circuit, on this particular engine, is made and broken by the contact and separation of two copper pins under an oil bath, thus preventing wear of their tips through sparking. The spark gaps, to which reference has been made, occur in the secondary or high-tension circuit, in addition to the spark gap, proper, between the ignition points of the plug itself.

It was found, by workmen of Panhard-Levassor, that an *outside* spark gap, in *series* with the jump-spark circuit, occasioned a much fatter and hotter spark between the ignition points. The device has been carefully worked out and ascertained to be an almost certain cure for weak or ineffective ignition due to uncertain battery action or other troubles, besides serving as a valuable indicator of the working of the igniting apparatus. About the only trouble likely to falsify the accuracy of its indications is the formation of soot or other deposit between the points of the spark plug.

CHAPTER XVII.

FOUR-CYCLE DOUBLE-ACTING ENGINES.

208. The Nürnberg. This engine has been designed especially for the use of blast-furnace gas, and, therefore, it is also well adapted to the perfect utilization of coke-oven gas, and various kinds of producer gas.

Up to the present time, it has been built in sizes ranging from 250 to 3,200 horse-power, but it is understood that the manufacturers are ready to build engines up to and exceeding 6,000 horse-power.

The engine has two cylinders placed tandem or one in front of the other, the four-cycle operations taking place at each end of either cylinder, thus giving the double-acting effect. This arrangement requires that each cylinder end be provided with three distinct valves. First, the inlet valve for admitting air or explosive mixture to the cylinder; second, the gas valve for regulating the amount and period of gas admission for each impulse; and third, the exhaust valve.

Fig. 83, gives a longitudinal section of the engine, showing the general arrangement of the interior and location of the valves. *Fig.* 84, is a cross section through the valve chambers. *Fig.* 85, illustrates the mechanism for operating the gas valves.

Referring to *Fig.* 84, it will be noted that the inlet and exhaust valves are of the poppet type, positively operated by a simple form of valve gear. The inlet valve opens about the time the crank reaches one dead center, and closes when it reaches the opposite one. The gas valve is operated by a governor-controlled mechanism illustrated in *Fig.* 85, the gear being that which is commonly known as the "*Marx*" patent

gear, which is specially adapted to the operation of the valves of large-sized steam and gas engines.

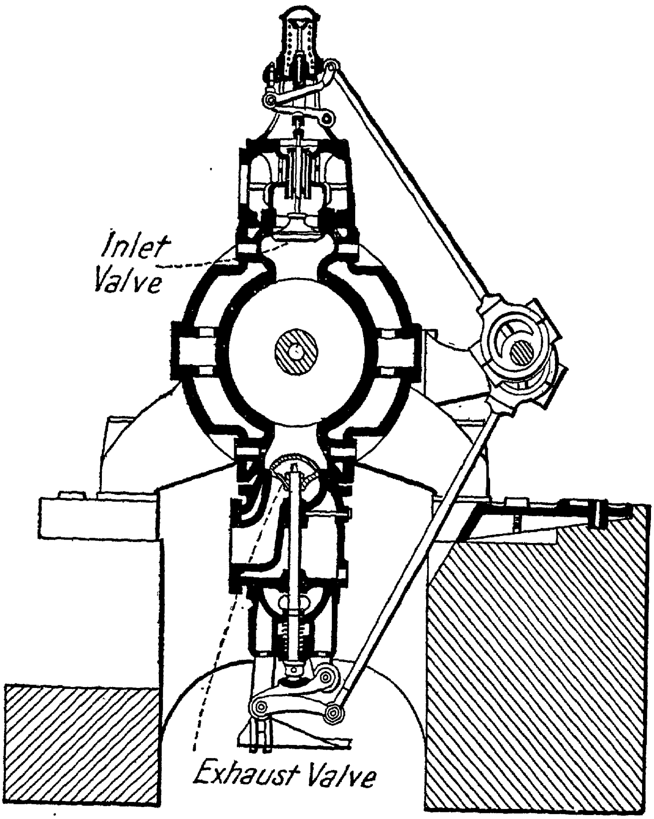

FIG. 84.—NÜRNBERG ENGINE.
Section through Valve Chambers.
(Paragraph 208.)

Referring to *Fig.* 85, it will be noted, that the forked rod, A, is actuated by an eccentric on the lay shaft, the upper end of A, being carried by the swinging link, B. The hook, C,

which engages the outer end of the rolling lever, D, is pivoted to the pin, E, and the inner end of D, is connected to the gas valve stem. The lever, F, is provided with a curved upper edge which supports the lever, D. One end of the lever, F, is fulcrumed upon a pin fixed in the valve bonnet, while the other end is raised and lowered by the arm, G, which is actuated by the governor through the arm, I. When the outer end of the lever, D, is depressed by the hook, C, the rocking motion imparted to D, lifts the inner end, and with it the gas valve, the hook releasing the lever at the end of the piston stroke. It will be noted, that as the outer end of the lever, F, is depressed by the governor, the motion of the lever, D, is modified to such an extent that the gas valve is lifted later in the stroke of the piston, so that by varying the position of the lever, F, the gas valve can be opened at any point in the stroke according to the demand and consequent speed of the engine, and the position of the governor. The gas valve opens with a quick action, and closes instantaneously, but it is easily seated or prevented from pounding by means of the dash-pot, J. The exhaust valve is opened by a simple rolling lever operated by an eccentric on the lay shaft.

By this entire arrangement, the air and mixing valves, as well as the exhaust valves, are operated and closed while the crank is close to the dead centers, and the gas valve is opened earlier or later in the stroke according to variations in the load, accompanied by a proportionate throttling of the gas.

It will be noted, that the exhaust valves are placed in the very lowest part of the cylinder, so that any dust carried into the cylinder by the gases, and any carbonized oil formed in the cylinders, will be swept out through these valves and not be permitted to collect and injure the pistons and cylinder walls,

Each end of every cylinder is provided with two distinct igniters, thus insuring perfect ignition and combustion of the gases, and providing a safeguard against mis-firing in case one of the igniters fails to act. Also provision is made, in the event of an injury to any valve, for cutting out of operation the end of the cylinder in which this valve is located, by shutting off the ignition and gas admission to that particular cylinder only.

All parts of the engine such as the cylinders, cylinder heads, pistons, piston rods, etc., are thoroughly water-jacketed or otherwise water-cooled, and all important moving parts are provided with pressure lubrication, the oil being automatically collected, filtered, cooled, and pumped through these parts so as to maintain a positive and continuous lubricating effect.

The piston rods are fitted with a special form of floating metallic packing, and the crosshead connections are so arranged that the cylinder covers may be slid off the rods without deranging this packing, whenever it is desired to overhaul the pistons. These lattter are provided with plain cast-iron spring rings.

The lay shaft with its eccentrics, the gear for operating the mixing valves, and all regulating devices, are located above the floor, thus being always in sight and easily accessible.

The construction of the entire engine and its supports permits of its free expansion lengthwise without in the least affecting its alignment. In all but the very largest sizes, the main frame and slide are cast in one piece.

These engines are built by the Allis-Chalmers Co., and are especially adapted to rolling mill and electric power-transmission installations, which, as a rule, require large power generating units.

209. The Blaisdell. This engine is a double-acting fou cycle engine having two power cylinders, A and B, place tandem as shown in *Fig.* 86, and a compressor cylinder, (placed tandem to the two power cylinders.

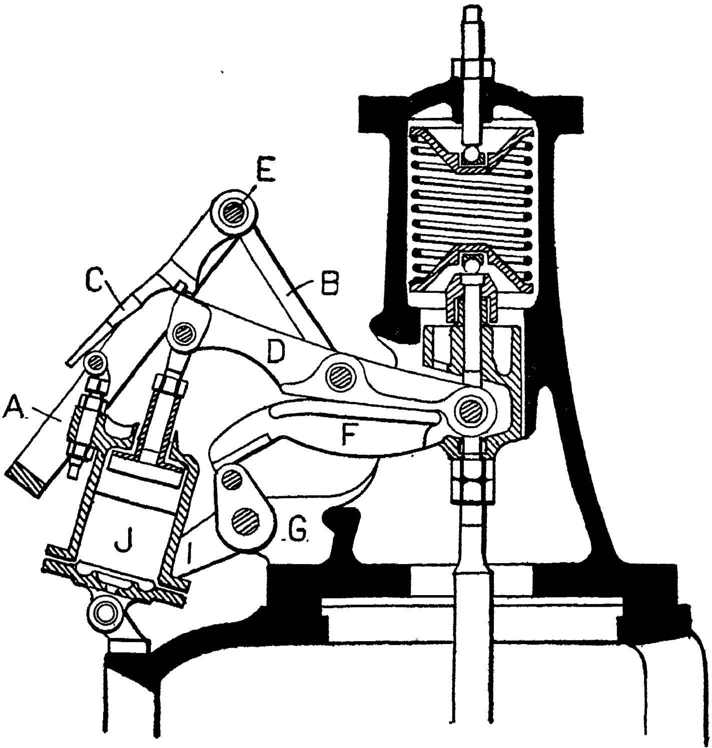

FIG. 85.—NÜRNBERG ENGINE.
Gas Valve Mechanism.
(Paragraph 208)

The tandem arrangement of double-acting four-cycle cyli ders gives the same number of impulses as a double-actin steam engine, with equal uniformity of turning effort.

Fig. 87, is a cross section through the valves, and *Fig.* 88, a detail of the igniter mechanism.

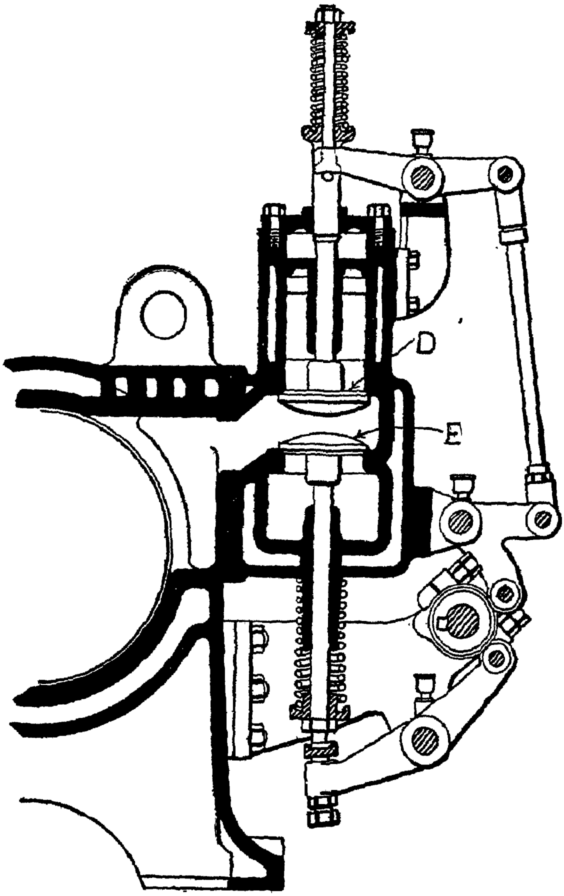

FIG. 87.—BLAISDELL ENGINE.
Cross Section through Valve Chambers.
(Paragraph 209)

Referring to *Fig.* 87, the valves are of the poppet type, working vertically, and are held to their seats by means of

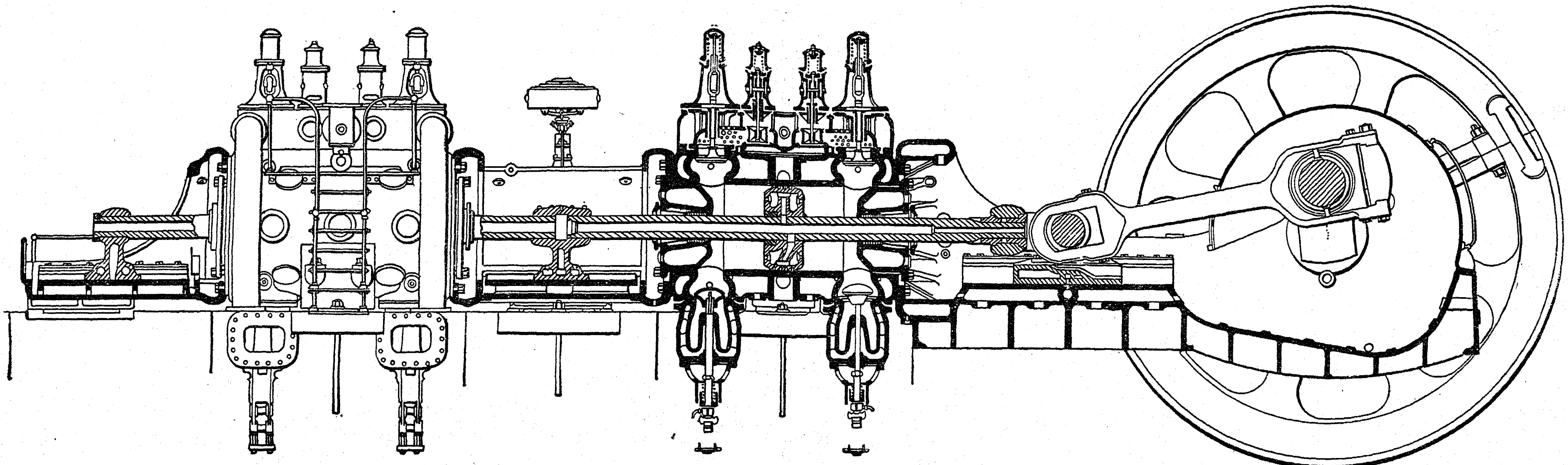

Fig. 83.—NÜRNBERG DOUBLE ACTING ENGINE,
Longitudinal Section.
(Paragraph 208)

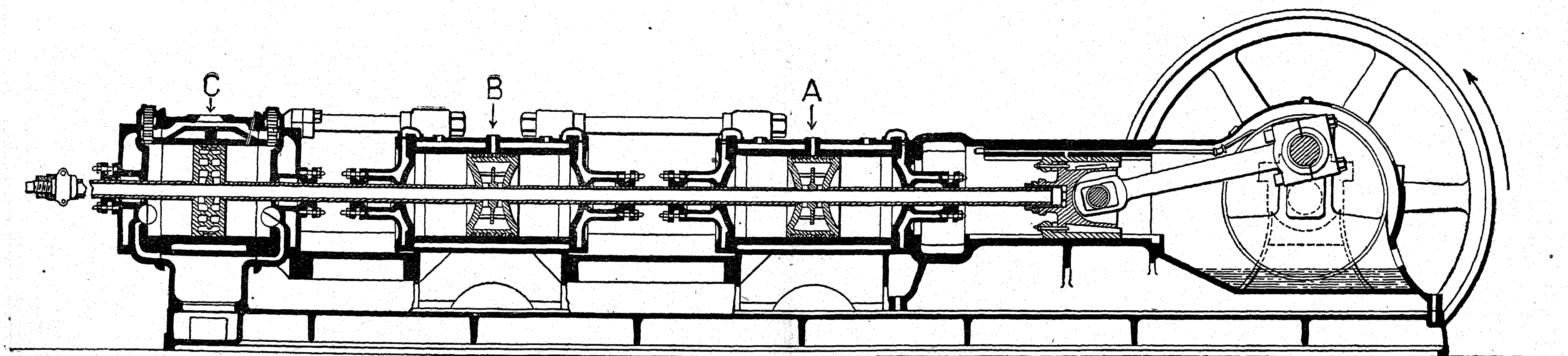

Fig. 86.—BLAISDELL DOUBLE ACTING ENGINE,
Longitudinal Section.
(Paragraph 209)

springs. The admission valve, D, is located immediately above the exhaust valve, E, thus causing the entering charge to pass directly over the head of the latter, keeping its temperature

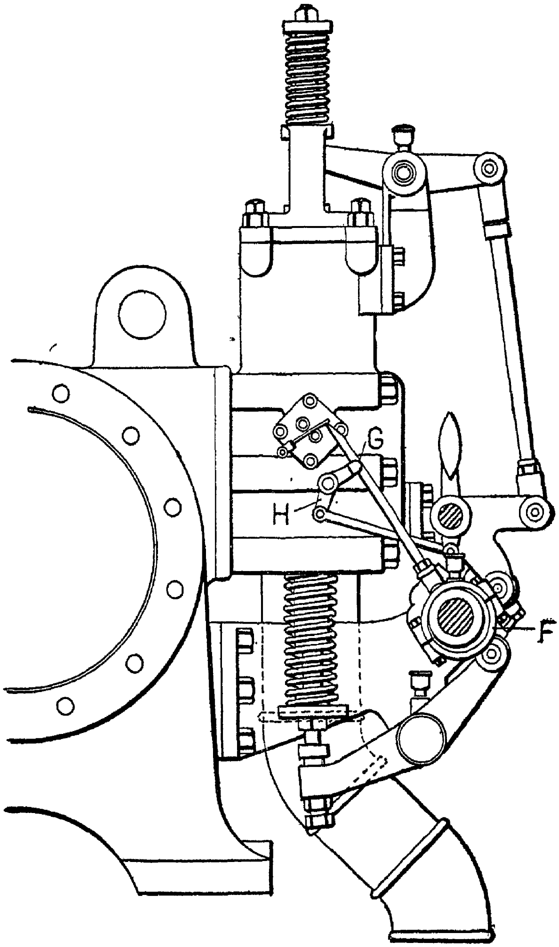

FIG. 88.—BLAISDELL ENGINE.
Detail of Igniter Mechanism. (Paragraph 209)

sufficiently low to render water-cooling unnecessary. The admission valve is placed in a cage as shown, which can be readily removed so as to expose the exhaust valve and permit its removal through the opening ordinarily filled by the cage.

Referring to *Fig.* 88, the igniter and valves are operated by a cam on the side shaft, a single cam being employed to operate both the admission and exhaust valves. The igniter mechanism is a special form of make-and-break contact operated by an eccentric, F, the rod of which rests in the small forked timing lever, G, forming one arm of the rock shaft, H.

The design is plain and substantial, provision being made for easy inspection and adjustment. The water-jacketing is very thorough, the tubular piston rods being under a pressure of 25 to 30 pounds. The crank, crosshead, etc., are splash lubricated.

The engine is started by means of compressed air, one cylinder being operated as an air motor until an impulse is obtained in the other cylinder, after which the engine continues to run on its own fuel.

210. **The Cockerill.** These engines operate on the four-cycle principle, and are built with one, two, or four cylinders, placed either single, tandem, twin, or twin-tandem. They are specially designed for the utilization of blast furnace gases, and are built in this country under license from the celebrated Belgian firm.

Fig. 89, shows a general view of a 500 horse-power tandem engine. *Fig.* 90, is a cross-section through one of the cylinders, showing the valves and valve gear.

Admission is effected by means of valves operated by cams keyed to the side shaft, which makes but half the number of

revolutions of the main shaft. Governing is effected by means of a centrifugal governor controlling either the quantity or the quality of the charge. If the first, the admission of a constant mixture is automatically cut off or throttled, resulting in variable compression. By the second method, the mixing valve is open throughout the charging stroke, the gas valve opening later than the others, at a point determined by the governor. This varies the relative proportions of air and mixture, giving constant compression, which is desirable for engines connected to dynamos.

The valves of each cylinder-end are operated by a single cam, thus requiring only a total of eight cams for a four-cylinder engine.

Referring to *Fig.* 90, the operation of the valve gear may be explained as follows: The side shaft, A, which is driven by the engine shaft, makes one revolution to two of the latter, and carries a cam, B, for each cylinder end. This cam revolves in the direction indicated by the arrow and operates both the admission and exhaust valves.

When the lobe of the cam begins to act on the roller, C, the latter and the rod, D, rise, the lever, E, oscillates, and its end, F, descends. This movement causes the mixing valve, G, and the air valve, H, to open, the latter, which is fixed to the mixing valve, uncovering the air ports, I. The time of opening of these valves corresponds exactly to the dead center position of the piston at the beginning of the suction or charging stroke.

During the first part of the stroke, air only is allowed to enter the cylinder. The double-beat gas valve, J, which is concentric with the mixing valve, remains closed. It is operated by the lever, K, the outer end of which, L, engages with the latch, M, of the lever, N, when the admission valves

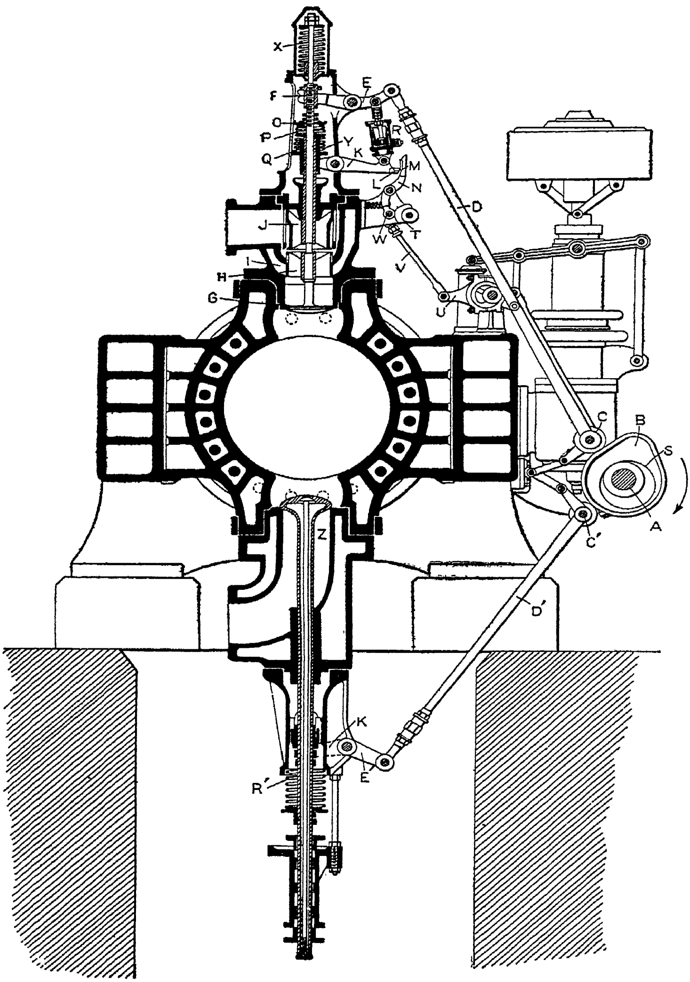

FIG. 90.—COCKERILL ENGINE.
Cross Section through Cylinder and Valve Chambers.
(Paragraph 210)

are on their seats. When the mixing valve opens, the spring cap, O, fastened to its stem compresses the spring, P, as the spring cap, Q, on the other end is fastened to the hollow stem of the gas valve, which, being blocked by the latch, remains closed. The connection, R, and its parts, act as a link of variable length between the levers, E and K.

An eccentric, S, on the side shaft, A, operates a small cam, T, by means of the rod, D, the oscillating lever, U, and the rod, V. The center of oscillation of the lever, U, is variable and controlled by the governor, and the effect of the displacement of this center is equivalent to a change in the length of the rod, V. The cam, T, operating on the roller, W, secured to the end of the lever, N, disengages the latch, M, at a definite moment predetermined by the action of the governor, and the gas valve, J, opens quickly, the amount of opening being limited by the space between the piston and the bottom of the dash pot, R. The proportions of the levers, E and K, are such that the opening of the valves, J and G, and also the air valve, H, bear a fixed relation to each other. From the moment the gas valve opens, as predetermined by the position of the piston during the suction stroke, both air and gas in proportions to give a good mixture are admitted regardless of the moment of cut-off.

The three valves remain open until the end of the suction stroke. At this instant, while the roller, C, descends on the lobe of the cam, B, the large spring, X, closes the mixing valve and the air valve, and the link, R, returning to its original length transmits the descending motion of the levers, E and K, and closes the gas valve. A small spring, Y, is employed for the purpose of allowing the mixing valve to continue its motion and seat itself in case the gas valve shuts first. The admission

and exhaust ports of the cylinder now close, and the charge is compressed by the return stroke of the piston.

A little before the crank reaches its outer dead center at the end of the expansion stroke, the lobe of the cam, B, touches the roller, C′, and acts by means of the rod, D′, and the levers, E′, and K′, and opens the exhaust valve, Z. This valve remains open during the exhaust stroke, and is closed by means of the spring, R′, when the crank reaches its inner dead center at the beginning of the next suction stroke, the spring always tending to close the valve and press the roller, C′, against the cam, B.

The cylinders are supported within a cradle formed in the framing, one end only being bolted to the bed-plate, thus permitting free longitudinal expansion. The cross head guides relieve the cylinder walls of the weight of the pistons and rod. The cylinders, heads, exhaust valves, and pistons are all water-cooled, the piston-rod nut also, as a preventive of premature ignition (Par. 309).

The engine illustrated is started by an explosion of carburetted air charged by a gasoline carburetter, the fly-wheel being turned round to compress the charge. Large units have a special compressor, furnishing compressed air for starting purposes. The turning of the engines is effected by an electric motor or hand worm-and-ratchet gear acting on teeth in the fly-wheel rim.

The gas used in these engines requires to be carefully purified and cooled. It is desirable that it should be completely cleansed from tar and naphtha, and it ought not to contain more than one-thirtieth of an ounce of dust per cubic yard. The best results are obtained when the admission temperature is not greater than 75° Fahr. With a higher temperature, the power developed will be reduced proportionally with the

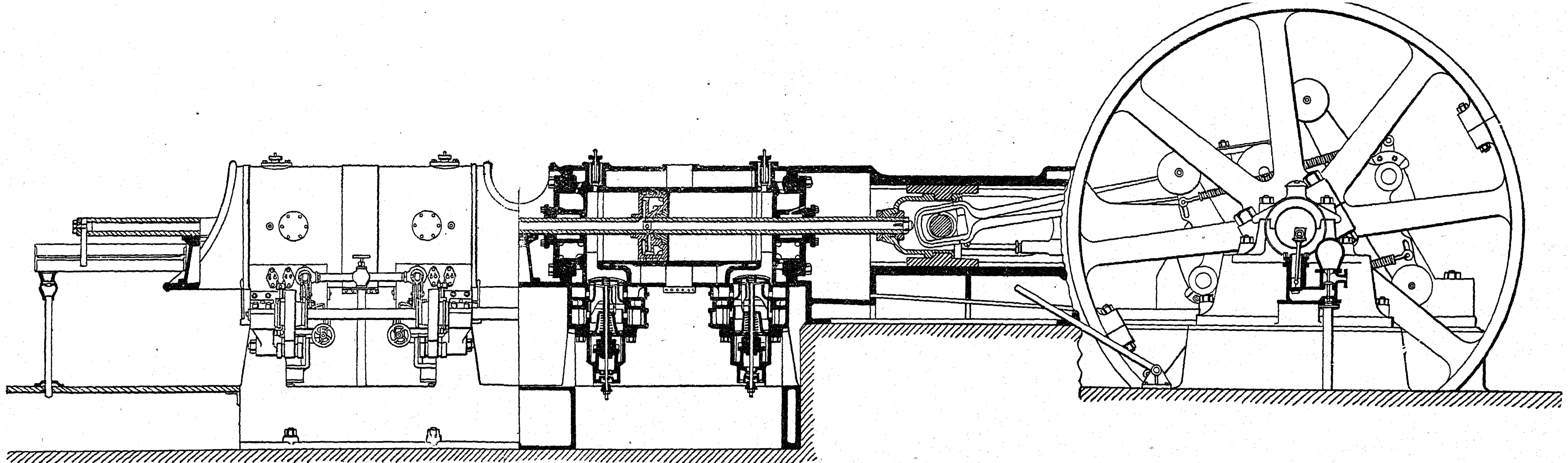

Fig. 91.—SARGENT TANDEM CYLINDER DOUBLE-ACTING ENGINE,
Longitudinal Section.
(Paragraph 212)

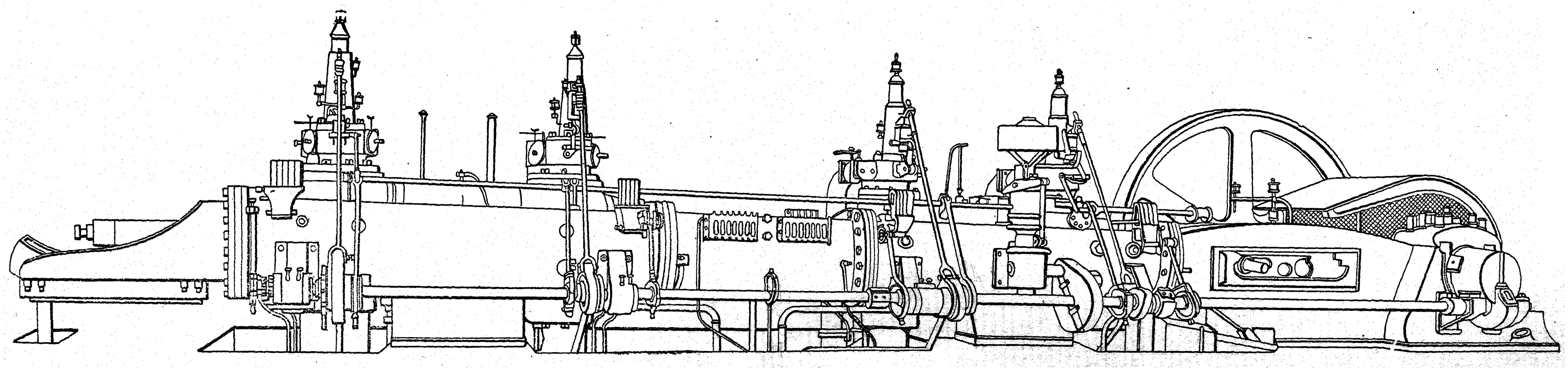

Fig. 89.—COCKERILL TANDEM CYLINDER ENGINE,
500 Horse-power.
(Paragraph 210)

lowered density of the gas. A larger proportion of dust than the amount specified, is liable to produce serious cutting in the cylinders.

The gas consumption depends upon its quality. A heat consumption of 10,000 B. T. U., per brake horse-power, and a thermal efficiency of 25 per cent. at the rated capacity of the engine are guaranteed by the manufacturers.

These engines are built up to 600 horse-power for each single-acting cylinder or 1,200 horse-power for each double-acting. Thus a twin-tandem double-acting unit may develop 5,000 horse-power, with a speed regulation comparable to that of large steam engines.

211. **The Snow Engine.** Among the larger sizes of gas-engines, the Snow has been eminently successful. This is a double-acting engine working on the four-cycle principle; two cylinders being usually arranged tandem fashion on the same piston rod so as to give an impulse at each stroke as in a steam engine. These engines have been constructed to use natural and city gas, also oil-gas from crude petroleum, as well as that generated by bituminous or anthracite producers.

The gas and atmospheric air are drawn, by separate passages, into a manifold extending the length of the cylinders; this serves as a mixing chamber, and from it the admission valve of each cylinder-end draws its supply of mixture for the charge. The admission valves are positively operated by means of cams on the half-speed shaft, but the cut-off is effected by an annular sleeve within the admission valve seating. The position of the governor arms controls the detents holding the cut-off sleeve and release the latter at a point corresponding to the demand for power. By this means the arranged propor-

tions of air and gas remain constant in the charge, whatever the power exerted, and there is no waste of unused charges as in a missed-ignition governor.

Closing the inlet before completion of the suction stroke expands the charge within the cylinder, so compression does not begin until the piston has returned to the point where the cut off was made. By these means the exploded charge is made to work expansively in the latter part of the working stroke, giving the same effect as the Atkinson Cycle, without the mechanical complexity of the Atkinson design (Paragraph 217). That this reduced compression does not create ignition troubles is shown by one of these engines having run successfully on a load factor as low as five per cent. The same engine —using producer gas—had a consumption of 2 ℔s. fuel per kilowatt-hour, which is equal to 1½ ℔s. per brake-horse-power-hour and shows great economy under the load conditions.

The governor is of a novel spring-loaded type, its weighted arms being connected by a horizontal bar which is threaded through them. Springs abutting against adjustable collars on the end of this bar serve as loading to the governor, and this arrangement causes the weights to follow a parabolic path, making the governor isochronous. Ignition is effected by means of a jump spark device, the electric current being supplied by a magneto.

The exhaust valves are controlled by cams on the half-speed shaft, and are water-cooled. The water-jacket service is very complete, including both heads of each cylinder, as well as the barrel. By means of telescopic or vibrating devices, water circulates through the piston rod and cross head, passing down a central pipe through the tubular rod and returning through the annulus around the pipe.

Forced feed lubrication is supplied to all working parts by means of mechanically operated pumps, and a series of tubes, leading to the crank-pin and cross-head-gudgeon, as well as to the stationary bearings.

These engines are chiefly made in the larger sizes. In one power-house in San Francisco there are four twin-tandem units each directly connected to a 4,000 kilowatt alternator, thus developing 5,400 brake horse-power for each set. This constitutes the largest gas engine installation at present in the world.

212. **The Sargent.** This engine is of the double-acting, tandem cylinder type, and is built in sizes up to 250 horse-power.

Fig. 91, gives the general design of the engine, and *Fig.* 92, a cross section through one of the cylinders, showing the valves.

Referring to *Fig.* 91, it will be noted that the sub-base extends from one end of the engine to the other, and is bolted to the foundation. The cylinders, fastened to the main frame, can slide back and forth upon the hollow supports rising from the sub-base, as the temperature varies. These supports maintain the alignment of the cylinders, and also convey the gas and the air from the hollow divided sub-base to the explosion chambers.

In this engine, the admission of the charge at full load is cut off from five-eighths to three-quarters of the charging stroke, according to the quality of the fuel used, which after compression and ignition is expanded to the cylinder volume, and released a little above atmospheric pressure at a temperature of about 400° Fahr.

The mechanism is comparatively simple, and avoids the employment of a multiplicity of valves and levers. A side shaft,

driven by a crank shaft and governor through worm gearing running in oil, and carrying two cams for each explosion chamber, one for the igniter and one for operating the valve, comprise all the moving mechanism except the valves and levers.

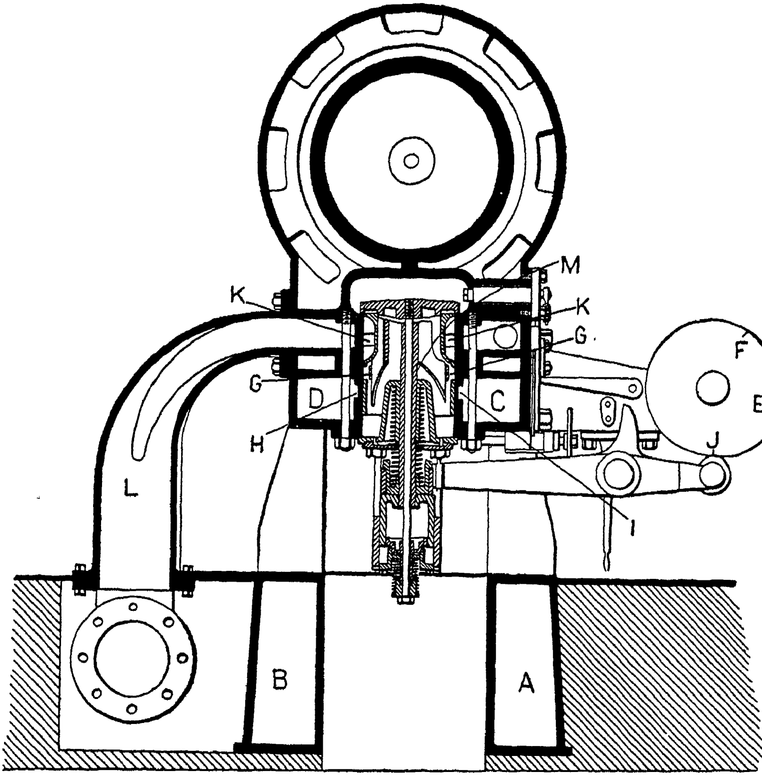

FIG. 92.—SARGENT ENGINE.
Cross Section through Cylinder and Valves.
(Paragraph 212)

Referring to *Fig.* 92, the general operation of the engine may be briefly described as follows: Gas is admitted to the

chamber, A, in the sub-base, and air to the chamber, B, each passing through the cylinder supports to the chambers, C and D, above, ready to enter into the mixing chamber when the depressed portion of the cam, EF, passes the roller, and the ports, GG, in the piston valve register with the ports, H and I, in the bushing. When the piston valve is depressed to this position, the confined air in the piston valve dash-pot forces the poppet valve open, and allows the free admission of the charge. When the point, F, of the cam reaches the roller, the latter is forced down, while the other end of the lever goes up, carrying with it the piston valve, which cuts off the admission. The poppet valve then seats, and both valves remain in the normal position during compression, ignition, and expansion, or until the point, J, on the cam pushes the roller down and the piston up, which opens the poppet valve and allows the exhaust gases to pass out through the ports, K, and the elbow, L, to the exhaust pipe under the floor.

The poppet valve seals the opening in the combustion chamber during compression and explosion, and the piston valve, released from pressure, works loosely in its bushing, thus cutting off the admission and guiding the exhaust.

As the poppet valve controls the entering as well as the exhaust gases, both valves and their seats are kept cool and do not require re-grinding more than once or twice a year. Through revolving the piston valve by means of the index wheel, the blind post, M, varies the mixture according to the calorific valve of the gas.

The speed is controlled by a Rites inertia governor, attached to the fly wheel, and operates by advancing the rotation of the valve shaft relatively to the crank-shaft as the speed increases, thus reducing the mean effective pressure with the load. As the

load decreases, the cut-off occurs earlier, and a lesser quantity of a constant mixture of gas and air is admitted into the cylinder; but, as the amount of the products of combustion in the clearance space remains the same, the mixture grows weaker and weaker, and the combustion slower. The time of ignition advances with the cut-off, becoming earlier as the mixture grows weaker, thus maintaining the highest pressure at the beginning of the stroke regardless of the load on the engine.

Cylinder lubrication is effected by a force feed pump or check-valve lubricators; the valves receiving sufficient lubrication from the cylinders. The side shaft and board bearings are self lubricating. The cross head guides, crank pin, and main bearings, which require thorough lubrication at all times, are copiously oiled by the worm gearing which acts as a pump.

Each combustion chamber contains two electric igniters, placed so as to be surrounded with a pure mixture at the time of ignition, thus reducing to a minimum the possibility of a miss-fire on account of a mishap to either of them.

Starting is effected by compressed air. When the air pressure is turned on in one cylinder, it puts the starting mechanism into operation, and that cylinder acts as an air motor until the other cylinder begins to run on its own fuel.

All parts of the cylinder walls, heads, piston rod, and pistons are thoroughly water-jacketed. All valves, levers, timing screws, and other parts requiring adjustment, are readily accessible, and every part of the working mechanism is located above the floor, but yet below the center line of the engine.

The time of ignition and the proportion of gas and air in the charge may be changed while the engine is in operation.

All combustion chambers are readily accessible by simply removing the cylinder heads, without any further dismantling of the engine.

213. **The Westinghouse.** In general construction, the double-acting Westinghouse engines embody the essential characteristics of the single-acting type described in paragraph 206; starting, governing and ignition being effected in the same manner as in the vertical type.

In the horizontal engine shown in *Fig.* 93, the construction from crank to cylinders is similar to that of a horizontal steam engine, but the design and construction of the cylinders, pistons, and valves conform to the best gas engine practice. The cylinders are double-walled with the outer walls split peripherally so as to permit of independent expansion and contraction during operation, and to relieve the stresses developed during the cooling of the casting. All cylinder heads are cored out for cooling-water circulation.

The valves are of the poppet type. Straight ports at the ends of each cylinder communicate with the combustion chambers, which are cast integral with the cylinders. The relation of admission and exhaust valves is quite similar to that of the single-acting type. The cylinders, combustion chambers, exhaust passages, pistons and piston rods are all water-cooled.

The pistons are fitted with spring packing rings; they are secured in position on the piston rods by lock nuts, and present plain convex surfaces to the burning gases. The piston rods are made of nickel-steel; they are hollow, affording the means of introducing cooling-water to the pistons, and are packed by metallic self-centering glands. The water enters at the cross head through a telescoping pipe connection and finally emerges

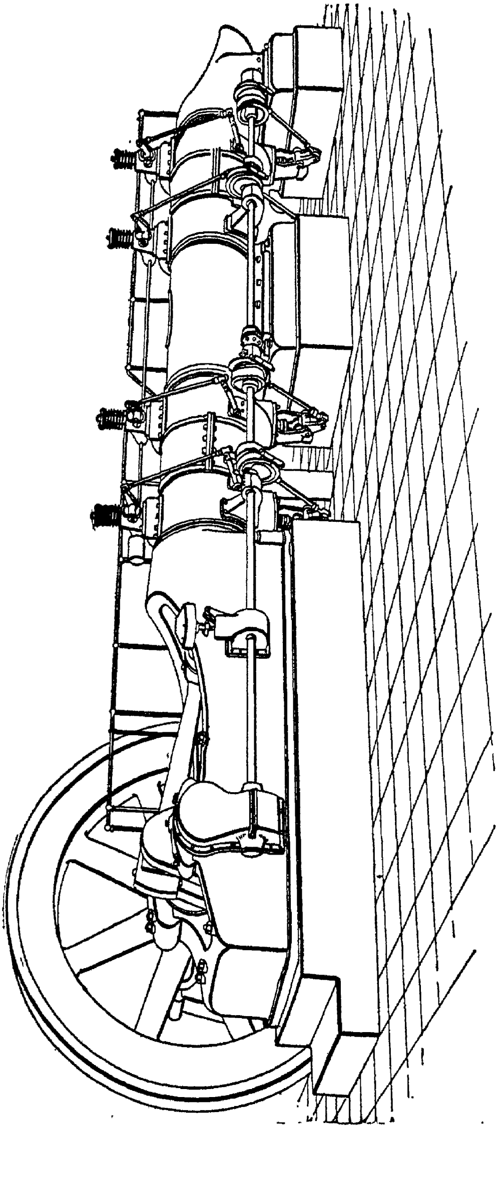

Fig. 93.—Westinghouse Double-Acting Engine.
(Paragraph 213)

through a bronze tail-rod which passes through the rear cylinder head into a cast iron jacket piped to the discharge main.

The cylinders and packing glands are lubricated automatically by multi-plunger pumps driven from the valve mechanism.

It has been demonstrated that the waste gases from blast furnaces can generate six times as much power, when utilized in a suitable explosion engine, as they would when burned under boilers to generate steam. The great difficulty attending the use of this fuel lies in the presence of about 5 per cent. of very fine dust, besides moisture from the ore. This necessitates preliminary settling of the gases; washers to remove any remaining dust; condensers to take out moisture; scrubbers to extract ammonia; filters of sawdust or other material to eliminate any other impurities; and holders to store the purified gas against the needs of the plant.

Blast furnace gas varies in composition, according to the ore and fuel employed, but may be taken as averaging,

CO	24.0
CH_4	1.0
H	7.0
CO_2	9.0
N	59.0
	100.0 by volume.

This gas has a calorific power of about 110 B. T. U. per cubic foot. One volume requires to be mixed with 1.13 volumes of air in forming the charge for an internal combustion engine.

Extended trials have shown the possibility of generating one horse-power-hour with the consumption of little more than 1 pound of fuel in the blast furnace, a result only approached by the very best steam engines, while the iron is smelted free of any fuel charge.

CHAPTER XVIII.

TWO-CYCLE ENGINES.

214. **Single and Double-acting Two-Cycle Engines.** The general working principle of this type of engine is fully described in paragraph 61. They were first proposed by Clerk and other English manufacturers, and were produced by them in small sizes. The recent discovery, however, that gases of low heating value, such as those given off by blast furnaces, could be effectively used in gas engines, together with the increasing demand for large engine units upwards of 1,000 horse-power, has led to the development of large and successful engines of this type, of both the single-acting and double-acting patterns.

Of the larger engines, the Koerting double-acting appears to be the most important, and serves very satisfactorily for the purpose of illustrating the salient features of the highest development of the type.

215. **The Koerting.** These engines are built in both the four-cycle and two-cycle types, in capacities ranging from 50 to 3,000 horse-power, and are designed to operate on natural, producer, coke-oven, or blast furnace gas.

Referring to *Fig.* 94, which shows the side elevation of a Koerting double-acting two-cycle engine; *Fig.* 95, a sectional plan; and *Fig.* 96, a cross section through the suction valve; the operation of the engine may be briefly described as follows:

Since the engine is double-acting, the crank end and the head end of the cylinder are similar, and the admission valves are

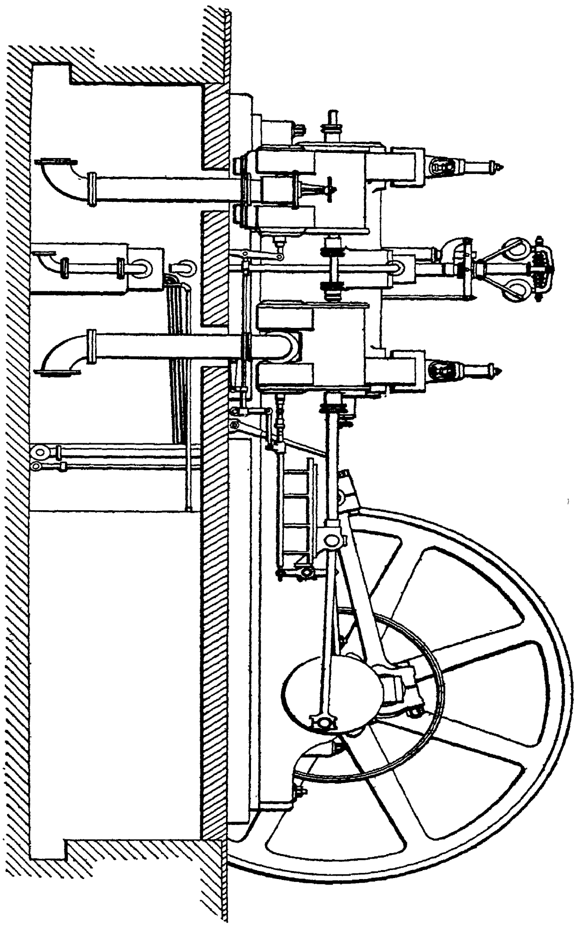

Fig. 91.—Koerting Two-Cycle Double Acting Engine. Side Elevation. (Paragraph 215)

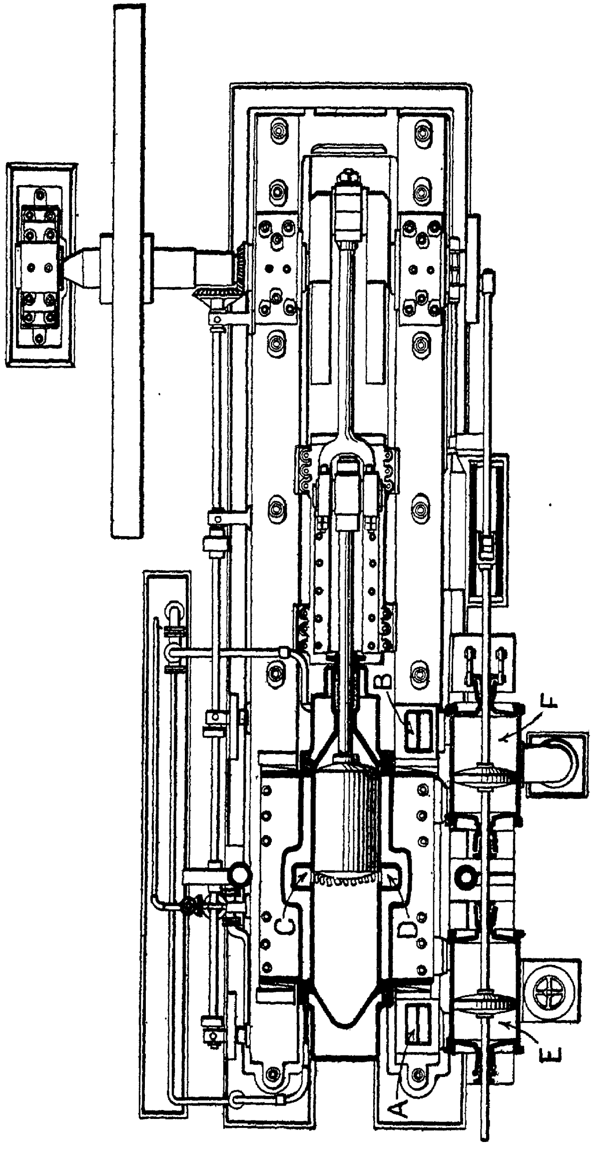

Fig. 95.—Koerting Engine, Sectional Plan. (Paragraph 215)

located in the valve boxes, A and B, bolted to the cylinder heads. No exhaust valves are required, the products of combustion being allowed to escape through the ports, C and D, cast in the middle of the cylinder and connected to the exhaust pipes. These ports are alternately covered and uncovered by the power piston itself, and, for this purpose, the piston is made very long and is packed at each end by self-closing piston rings.

The charge is admitted through two double-acting auxiliary pumps, E and F, one for gas and the other for air. The proportions of these pumps are such that their combined action always secures a mixture, having the proper proportions of gas and air for perfect combustion, and introduces the same into the working cylinder. The delivery branches of the pumps are divided and so arranged that the crank ends of both pumps discharge into the crank end of the power cylinder, and the head ends into the head end of the power cylinder. These pumps compress the gas and air to about nine pounds per square inch.

Referring to *Fig.* 95, it will be noted, that the piston is at the outer dead point, and that the exhaust ports are uncovered towards the head end of the cylinder. In operation, the instant the piston begins to uncover these ports, the pressure of the products of combustion of the previous charge drops rapidly to that of the atmosphere. and when this occurs, the inlet valve opens, and a fresh charge is admitted by the pumps. The valve gear of the pumps is so designed, that, at first, air only is admitted to the cylinder, thus separating the products of combustion from the succeeding charge of gas and air.

The entering charge is formed only at the inlet valve, and is not kept stored up, outside the power cylinder, as is more or less customary in gas engine practice. By the peculiar design of the admission device, the air, first admitted, is prevented

from mixing with the products of combustion remaining in the cylinder, or with the succeeding charge, and in a similar manner, suitable arrangements effectively prevent the loss of any

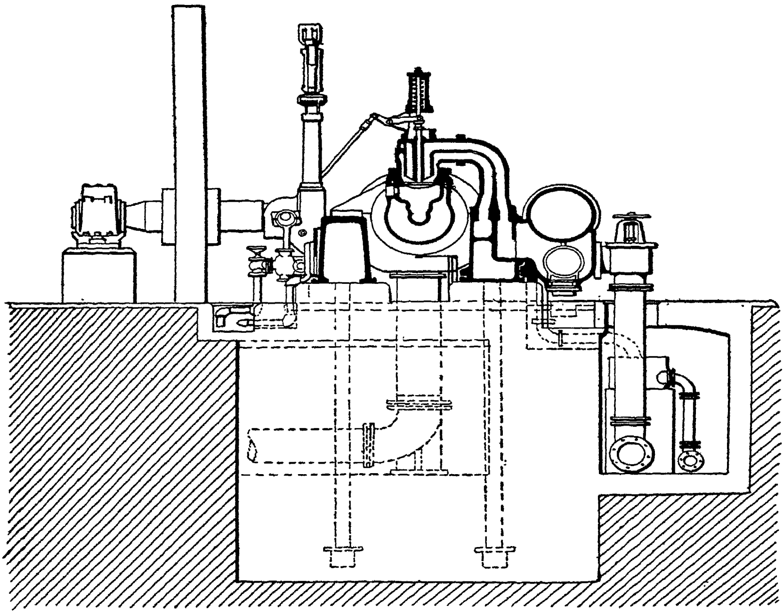

FIG. 96.—KOERTING ENGINE.
Cross Section through Suction Valve.
(Paragraph 215)

portion of the fuel charge through the exhaust ports, which remain open during this period.

Shortly after the exhaust ports are again covered by the receding piston, the air and gas pump pistons also arrive at their dead point position, and the supply of mixture is interrupted. The inlet valve now closes, and the charge is compressed in the cylinder, in the usual manner, until ignition takes place at the dead point of the stroke.

At the next movement of the power piston, the ignited charge expands, exerting pressure until the piston uncovers the exhaust ports and allows the blowing out of the consumed charge. The same operation takes place at the opposite end of the piston.

In order to secure the separating layer of air between the products of combustion and the fresh charge, the gas pump is so constructed that no gas is delivered until it has passed a certain point in its compression stroke. The pump is provided with piston valves operated by a valve gear so arranged that its maximum capacity cannot exceed 50 to 60 per cent. of its total displacement. For, after the pump has completed its suction stroke, the gas suction port is left open during a part of the compression stroke, so that the gas can return without increasing in pressure until the suction port is closed, when the gas is compressed and passed out through the compression port.

The development of power is regulated as follows: When the load on the engine is reduced, the gas pump furnishes gas at a correspondingly later period, thus discharging a reduced quantity of gas into the power cylinder. This is effected either by the valve gear of the pump under the control of the governor, or by means of a by-pass located between each pump-end and its respective compression channel leading to the inlet valve on the power cylinder. The throttling device located in this by-pass is also controlled by the governor.

It will be noted that the engine operates with a variable amount of mixture, and that, correspondingly, more or less air is at first discharged into the power cylinder. This air lies against the piston, while the combustible mixture remains at the ends of the cylinder near the inlet valves and igniters. The peculiar shape of the cylinder ends prevents the mingling of this layer of air with the succeeding fresh charge.

Ignition is effected by means of two spark coils, located at each end of the power cylinder, and operated by a separate shaft driven by spur gears from the cam shaft. The gear on the igniter shaft is not fast, but is connected to a sleeve having a feather set spirally around the shaft, so that, by a sliding movement of the wheel, the igniter shaft may be set behind or in advance of the cam shaft. In this manner, the time of ignition can be changed to suit the kind of fuel being used, while the engine is in operation.

Starting is effected by means of compressed air. A piston valve is provided for admitting the compressed air to both ends of the cylinder; this valve is operated from the cam shaft by an eccentric which can be thrown in and out of gear like a clutch. Filling the cylinder twice with air is usually sufficient for starting, after which the engine will continue to run on its own fuel.

The power cylinder and the piston are water-cooled. In the case of the piston, the water enters by a tube carried through the cross head pin and hollow piston rod, and returns in the same way through the annulus between this tube and the rod. The stuffing boxes in the cylinder head are surrounded by water, and the cylinder walls are cooled throughout, except at the middle, where the exhaust ports are located. The cooling of the charge during compression is increased by means of ribs

cast on the walls of the combustion chamber, the developed area of which is predetermined, by calculation, to suit the degree of compression which the ignition temperature of the gas will permit.

These engines are built by the De La Vergne Machine Co., of New York.

216. Double-Piston Two-Cycle Engines. In order to avoid many difficulties, such as premature explosions in the crank-case, insufficient scavenging of the products of combustion, etc., incidental to the operation of two-cycle engines on the general principle described in paragraph 61, numerous attempts have been made by various inventors to produce two-cycle engines operating with two pistons in a single power cylinder. This means that the cylinder is an open-ended tube, the explosions taking place *between* the two pistons, forcing them apart.

The first important engine of this type appears to be the Atkinson differential engine, of English make, and exhibited for the first time at the Inventions Exhibition in London, during 1885.

It is well to understand in this connection, that up to the present time, engines of this type have not proved very satisfactory practically, and that the brief descriptions of a few examples, given in this paragraph, are introduced merely for the purpose of showing in a general way the results of efforts in this direction.

217. The Atkinson Differential Engine. *Fig.* 97, gives a general view of the engine in elevation, and the four diagrams of Fig. 98, show the positions of the two pistons at different points of the cycle.

It will be noted that only one cylinder is used for all purposes of the cycle. Two trunk pistons work in the opposite ends of this cylinder, and are connected by an ingenious system of levers and short connecting rods to the crank shaft, the short rods causing the necessary action.

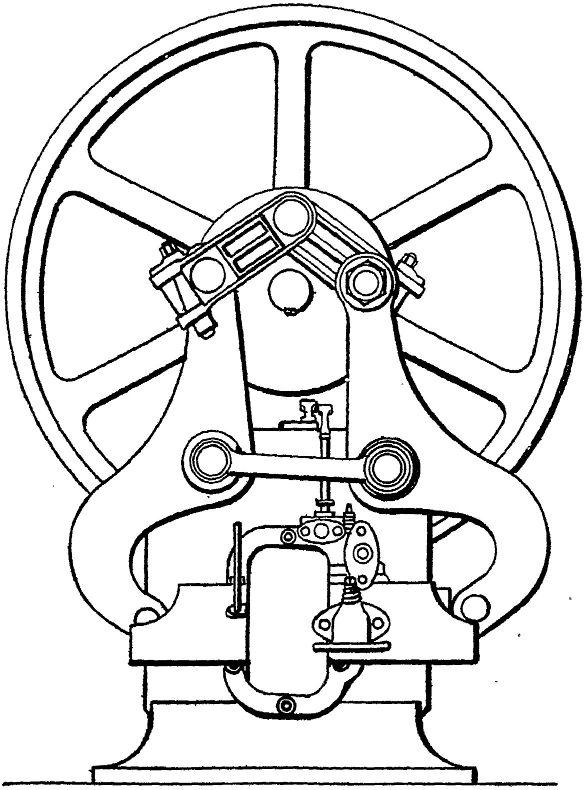

FIG. 97.—ATKINSON DIFFERENTIAL ENGINE. Side Elevation. (Paragraph 217)

In the first position shown in *Fig.* 98, the pistons occupy one extreme of their stroke and are just beginning to separate. The charge is now admitted between them through an automatic

lift valve. In the second position, the admission of the charge has been completed, and the further movement of the pistons is about to close the ports leading to the admission and exhaust valves. The charge is now subjected to compression, and when

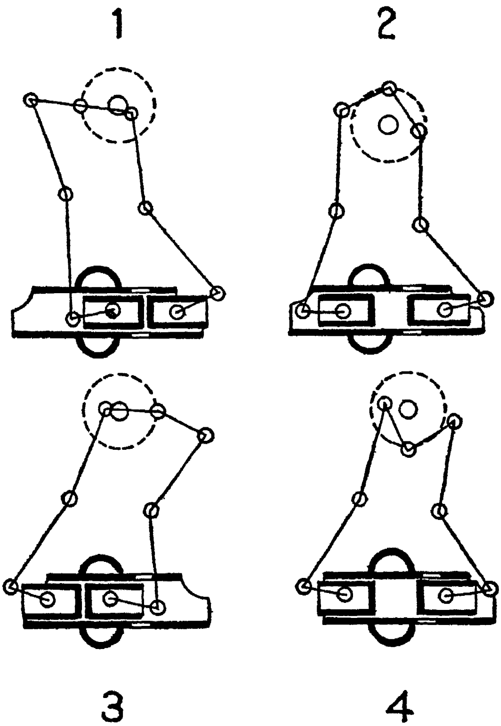

FIG. 98.—ATKINSON DIFFERENTIAL ENGINE.
Position of Piston at different points in the Cycle.
(Paragraph 217)

this process is completed in the third position, it is ignited, the resulting explosion causing the pistons to separate rapidly, and uncover the exhaust port and discharge the products of combustion in the fourth position.

By this arrangement, the operations of admission, compression, ignition, expansion, and expulsion are performed in the single cylinder during one revolution of the crank shaft. Only two automatic valves are employed, and these are never exposed to the pressure of the explosion, the pistons themselves acting as valves in certain parts of the cycle so as to uncover the exhaust and admission ports when required, and to uncover the ignition port at the proper time.

218. **The Riker,** (*U. S. Patent No. 349,858—1886.*) The specifications, under this patent describe an engine consisting of a single cylinder open at one end, and having two pistons working therein in opposite directions as follows:

Referring to *Fig.* 99, and assuming the engine to be at rest with the working parts in the position shown in the drawing. The pistons are respectively at the upper and lower limits of their movement, the lower exhaust port, A, is closed, while the corresponding supply port, B, has just opened. To start the engine the crank shaft is revolved by hand, and as piston, C, begins to ascend, a partial vacuum is created in the lower part of the cylinder, the suction drawing in a charge of air and gas through the port, B, into the chamber, D, the cock, E, being so turned that the lower gas port is opened. As piston, C, continues to ascend, the accompanying ascent of the rod, F, closes the port, B, and turns the cock, E, so as to shut off the supply of gas. When port, G, comes opposite the burner, H, an explosion occurs. The pistons now approach each other, and when they reach the limits of their stroke in this direction, the exhaust port, J, which up to this time has been open is closed by the valve, K. The same motion of the rod, L, also opens the lower exhaust port, A, so that as the piston, C, descends, the

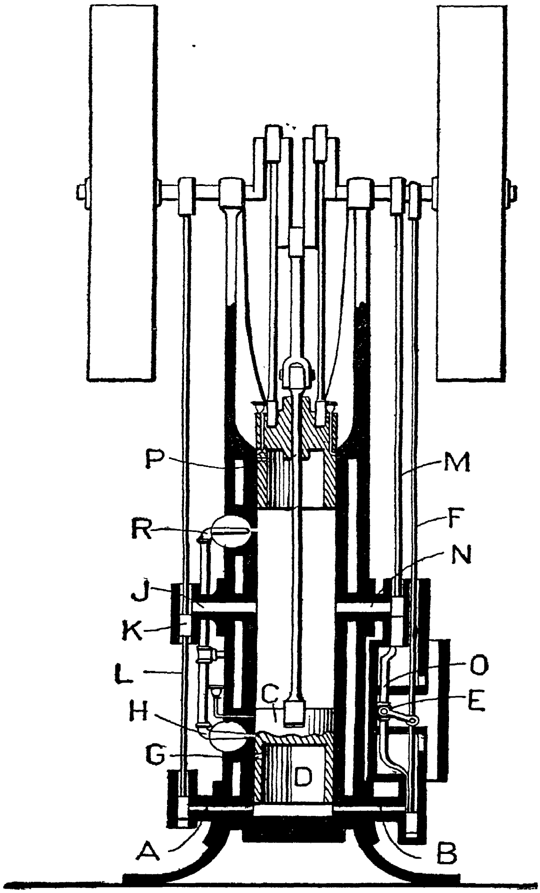

FIG. 99.—RIKER DOUBLE-PISTON TWO-CYCLE ENGINE,
(Paragraph 218)

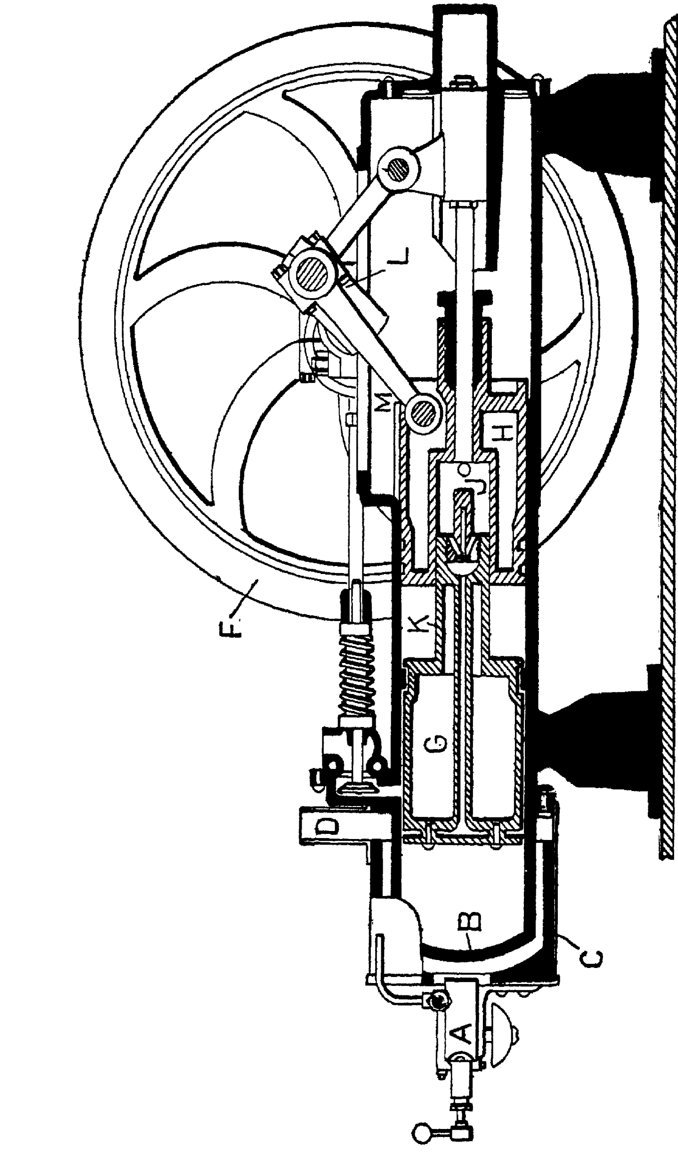

FIG. 100.—ANDERSON-ERICKSON-WICKSTROM DOUBLE-PISTON TWO-CYCLE ENGINE.
(Paragraph 219)

products of combustion of the first charge are driven out of the cylinder. By this time, the rod, M, has opened the supply port, N, and rod, F, has reached the top of its stroke, closing supply port, B, and turning the three-way cock, E, so as to open the upper orifice of the gas pipe, O. This is the position of the parts when the pistons begin to separate. A charge then enters through the port, N, and is ignited when the ignition port, P, comes opposite the gas burner, R. The resulting explosion drives the pistons apart.

219. The Anderson-Erickson-Wickstrom, (*U. S. Patent No. 714,356—1902.*) The specifications of this patent describe an engine capable of being operated either by heated air, or by an explosive mixture of air and gas. It employs two pistons working in a single cylinder, and operates as an internal combustion motor as follows:

Referring to *Fig.* 100, the burner, A, having been heated in any ordinary manner to a temperature sufficiently high to vaporize the fuel oil used, its valve is opened and the burner ignited. The flame thus obtained is directed upon the inner end of the heater, B, and being deflected around its sides in the space between the heater and the refractory lining, C, discharges the products of combustion into the atmosphere through the vessel, D. When the heater has thus attained the required temperature, the fuel admission valve, E, is opened and the fly wheel, F, is given an initial revolution, whereby the transfer piston, G, and the power piston, H, will recede from each other, drawing air into the space formed between them, and fuel gas or vapor into the cylinder, J, behind the trunk piston, K. The pistons having, during their opposite or separating movement, thus drawn in the required amount of air and vapor, the trans-

fer piston, on account of the manner of its connection to the crank, L, will remain substantially stationary at the end of its instroke, while the power piston, on account of the manner in which it is connected to the crank, L, will travel rapidly inward toward and behind the transfer piston, thereby compressing the charge in the comparatively cool parts of the cylinder. At about the completion of the instroke of the power piston, the transfer piston commences its outstroke, and by traveling towards the power piston transfers the charge to the combustion chamber within the heater, B, where it is automatically ignited by direct contact with the heated walls, expands and drives the pistons outward on the power stroke. When the pistons have almost completed their outstroke, the exhaust valve, M, is opened by suitable actuating devices and discharges the products of combustion into the atmosphere.

The engine having thus received its power stroke, the momentum of the fly wheel causes the next intake, compression and transfer of the charge, followed by the second impulse, so that one power stroke is obtained during each revolution of the crank shaft.

220. The Clifton, (*U. S. Patent No. 792,119—1905.*) This patent describes an engine of the vertical type, having one cylinder with two pistons working therein. The cylinder is provided with an inlet valve at one end and an exhaust port at the other, and the compression chamber is partly formed by the pistons themselves. The charge is drawn in on the inlet valve side of the piston and compressed into the compression chamber from which it is transferred to the other end of the cylinder and there ignited.

Referring to *Figs.* 101, 102, and 103, which are sectional views of the cylinder showing the pistons in different positions, the action of the engine may be described as follows:

On the down stroke, the products of combustion are expelled from the lower or ignition side of the piston, B, through the exhaust valve casing, J, while at the same time a fresh charge is drawn into the cylinder on the compression side of the piston, A, through the suction valve casing, K, as shown in *Fig.* 101.

On the upstroke, the charge drawn is above the piston, A, is compressed into the space between the two pistons, the fluid pressure overcoming the resistance of the spring, E, and forcing the piston, B, away from the piston, A, as shown in *Fig.* 103, the charge being trapped in the space between them, which thus forms the compression chamber.

At the end of every downstroke, the charge compressed between the pistons is delivered through the ports, G, into the cylinder space below the piston, B. As the charge escapes, the piston, B, moves up to the piston, A, so that they are again in touch before the charge is ignited as shown in *Fig.* 102, and both commence their upstroke together. Near the end of the upstroke, the compression on the charge drawn in at K, will overcome that of the spent charge, and while the piston, A, completes its upstroke, allowing the fresh charge to pass through the passages, C, in the piston A, the piston, B, will be gradually stopped by the pressure of the charge passing through the piston, A. When the piston, A, reaches the top of its stroke, practically all of the gas is trapped between the pistons and carried down by them to the lower part of the cylinder, while at the same time another charge of gas is being drawn in at K. Thus, on the following upstroke, explosion and compression occur simultaneously on different sides of the pistons.

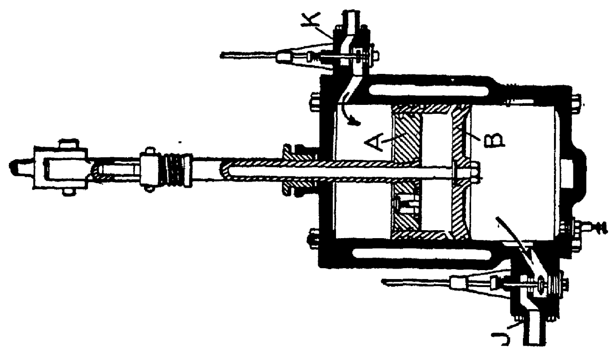

Fig. 101.

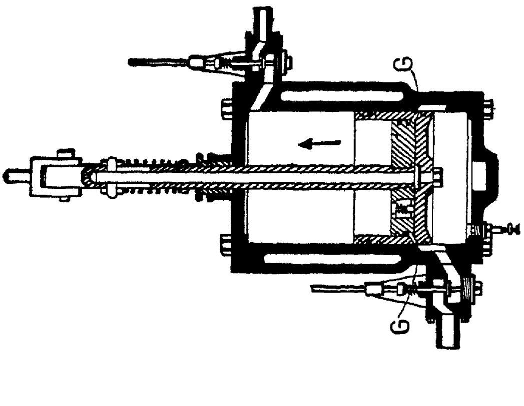

Fig. 102.

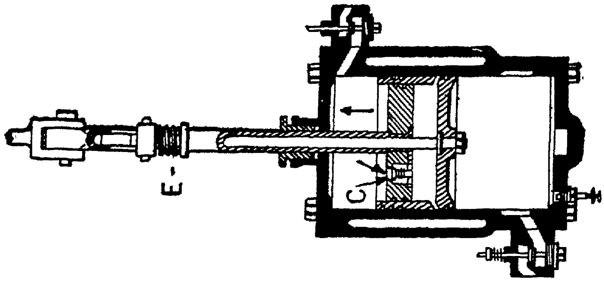

Fig. 103.

Clifton Double-Piston Two-Cycle Engine.
Sectional View of Pistons at different points of the Cycle.
(Paragraph 220)

The advantages of a two-cycle motor over the four-cycle are due to the greater frequency of its impulses, and may be stated as: 1, more uniform and sustained rotating effort or torque, lending itself to more accurate governing and greater flexibility in meeting a varying demand; 2, lessened weight for equal power; 3, uniform compression, with consequent economy, as no more exhaust can go out than charge come in, thus keeping the same total quantity of charge in the cylinder, the action of the governor tending to vary only the proportions of gas to the total charge.

The chief disability, under which the ordinary classes of two-cycle motors appear to have labored, is a certain lack of positiveness in functioning as compared with the rival type. The various engines illustrated and described in these paragraphs have been devised with a view to removal of this disability, and, in their efforts to attain this end, the inventors have produced machines offering a marked contrast to the extremely simple two-cycle marine engines described in Chapter XXI.

It is, however, conceded by many authorities that a certain amount of complexity is necessary to give absolutely positive action to the two-cycle motor, either by the addition of inlet and gas valves or by auxiliary charging and scavenging cylinders. On the other hand, the exhaust valve, a chief source of trouble in internal combustion engines, may be dispensed with by adopting the two-cycle mode of operation, and the trend of modern practice seems to favor this view of the question.

For further information on the working principles of two-cycle engines—see paragraph 244.

CHAPTER XIX.

FOREIGN ENGINES.

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221. German Engines. It is well recognized that up to the years 1904 and 1905, the German gas engine makers led all others in the development of high powered internal combustion engines. Since then, however, this supremacy has been successfully contested by the American makers, but it will be noticed, that with one or two exceptions, such as the Westinghouse double acting engine, and the Sargent, the American product is of foreign origin.

The Nürnberg built by the Allis-Chalmers Co., The Cockerill made by the Wellman-Seaver-Morgan Co., and the Koerting of the De La Vergne Refrigerating Machine Co., are of German design; while the American Crossley is the American duplicate of the English Otto-Crossley. All of these are fully described in Chapter XVII, together with the Westinghouse and Sargent engines.

Of the other larger German engines, the most important are the Oechelhauser, built by the firm of A. Borsig, Tegel, near Berlin, and the Duetz, built by Gasmotorenfabrik Duetz, near Cologne.

222. The Oechelhauser. This engine is of the two-cycle, single-cylinder type, and one of the simplest among the numerous forms of large gas engines.

As shown by *Fig.* 104, two pistons, A and B, work in opposite directions in a long cylinder, C, which is open at both ends,

and provided with ports, D, E, and F, which, being uncovered consecutively by the pistons during their outward stroke, effect the distribution. The piston, A, first uncovers the ports, D, through which exhaust the compressed products of combustion, and, as soon as the pressure of the latter has fallen to that of the atmosphere, the piston, B, uncovers the ports, E, admitting pure air into the cylinder which sweeps out the products of combustion still remaining therein. Immediately thereafter, the piston, B, uncovers the ports, F, and admits a fresh supply of gas into the cylinder, where it mixes with the air which continues to enter at the ports, E, together forming the explosive mixture for the fresh charge. This charge is compressed by the

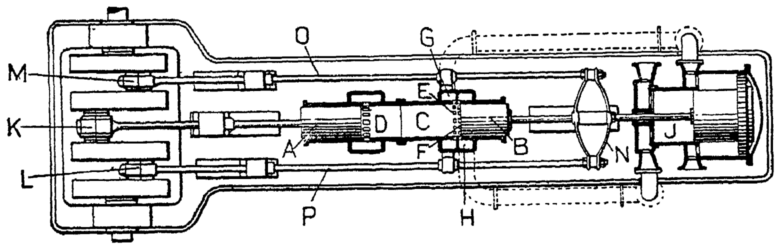

FIG. 104.—OECHELHAUSER TWO-CYCLE ENGINE.
Sectional Plan. (Paragraph 222)

return stroke and ignited by means of two magneto igniters when the pistons are in the middle of the cylinder, so that the force of the resulting explosion drives them apart, giving a power stroke for every revolution of the crank shaft.

During the compression and power strokes, the charging spaces, G, and H, the former for air and the latter for gas, are refilled by means of a pump, J, located behind the cylinder, so that a fresh charge under a low pressure, of about 4 to 6 pounds per square inch, is always held in readiness to enter the cylinder at the beginning of the outward stroke of the pistons.

The construction of the engine is such, that while air can enter the charging space for gas, gas cannot enter the charging space for air, thus preventing the gas from passing out through the exhaust ports, and, furthermore, the dimensions of the cylinder are such that only 70 per cent. of its full capacity is required to be filled with the charge for the development of the maximum power of the engine.

The piston, A, acts directly on the crank pin, K, of the three-throw crank shaft, and the piston, B, acts upon the two outside crank pins, L and M, by means of the cross-tail, N, and the connecting rods, O and P.

Governing is effected by regulating the quantity of gas admitted to the cylinder, so that the amount of gas in the charge is always proportional to the power demand at any moment.

The principal advantages of the engine are derived from the following conditions:

1. The reduced cylinder diameter diminishes the intensity of the forces acting on the driving parts.

2. The movement of the pistons in opposite directions enables the exact balancing of the reciprocating parts.

3. The transmission of the whole power developed by the engine through its moving parts alone, prevents the application of horizontal strains to the frame, and obviates the necessity for extra heavy foundations and strong holding-down bolts.

4. The absence of valves insures safe action and great durability.

The only valve employed is the small one used for starting the engine with compressed air. A compressor, coupled to an electric or gas motor, furnishes compressed air, under a pressure of about 300 pounds per square inch, to a vessel communi-

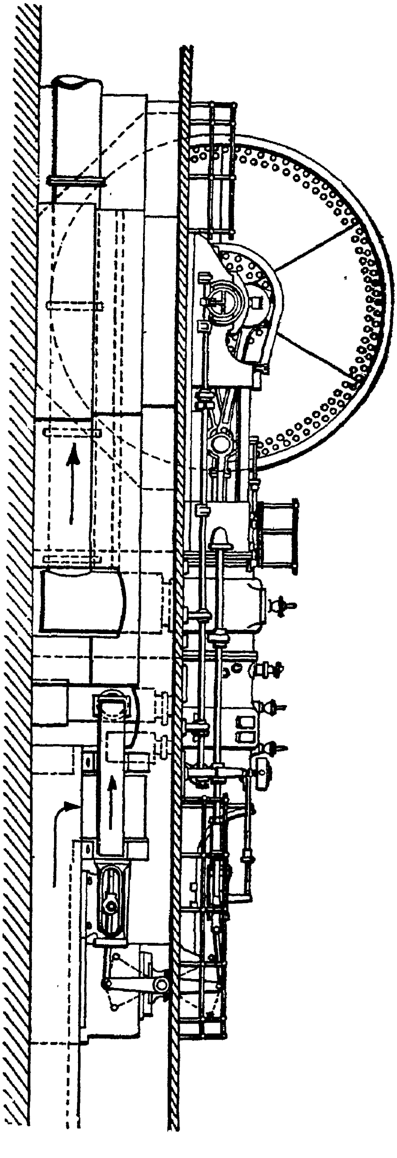

FIG. 105.—OECHELHAUSER ENGINE.
Side Elevation.
(Paragraph 222)

cating with the engine cylinder, through this valve which is controlled by the engine itself. After the first ignition the valve is closed, and the gear disengaged by the operator.

The engine is built in both the single and double-cylinder types, the former ranging in size from 250 to 1,500 brake horse-power, and the latter from 500 to 4,000 brake horse-power. They are capable of sustaining an overload of 10 per cent. above the figures given, when working regularly, and of 20 per cent. temporarily. *Fig.* 105, shows a side elevation of the engine.

223. **The Deutz.** This engine is of the double-acting four-cycle type and is built in sizes up to 6,000 horse-power.

Fig. 106, shows a longitudinal section of the engine, and *Fig.* 107, a vertical cross section through the cylinder and a set of valve chambers.

As shown by *Fig.* 107, the exhaust valves, A, are opened by a cam and link arrangement operated from the secondary or lay shaft, B, and are closed by means of springs. The admission valves are opened in the same way, by means of cams and linkages, but their travel is controlled and varied by the governor, C, through the bell-crank arm, D, carrying the roller, E, which serves as the fulcrum of the lever, F, operated by the cam mechanism.

The position of the roller determines the ratio of the travel of the reach rod, G, and that of the admission valves, and thus regulates the quantity of explosive mixture admitted to the cylinder.

The admission valves are composite, the air valve, H, being of the piston type and controlling the admission of air from the supply pipe in the usual manner. It carries at its upper end

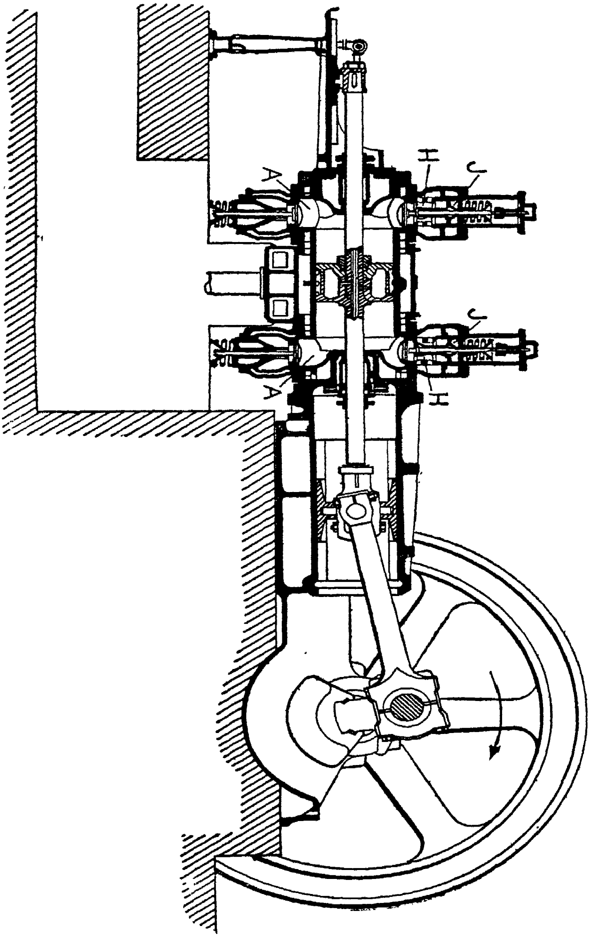

FIG. 106.—DEUTZ DOUBLE-ACTING, FOUR-CYCLE ENGINE.
Longitudinal Section.
(Paragraph 223)

a poppet valve extension, controlling the admission of gas through the port, J, into the valve chamber, where it is mixed with air and forms the charge. The action of the governor controlling the movement of the valves is so sensitive that the speed fluctuation is not over one-half of one per cent., when the load

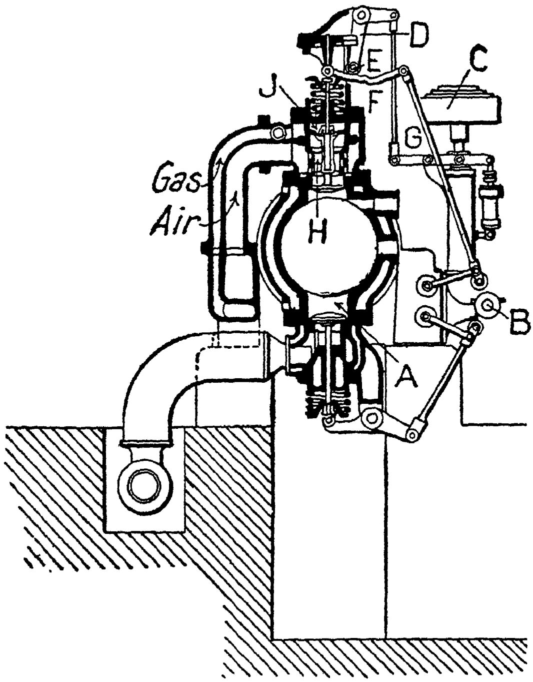

FIG. 107.—DEUTZ ENGINE.
Cross-Section through Cylinder and Valve Chambers.
(Paragraph 223)

is suddenly increased or decreased 25 per cent., and the variation in speed between no load and full load does not exceed three-quarters of one per cent.

The double-acting construction necessitates the use of stuffing boxes, but they do not appear to be the source of any trouble whatsoever.

Fig. 106, gives an idea of the general construction. The piston is packed by rings of a special type, and both the piston and piston rod are made hollow, thus providing passages for the circulation of cooling-water.

The arrangements for cooling have been made very carefully and effectively. The cylinder, cylinder head and valve, and the discharging valve and pipe receive cooling-water separately, thus permitting independent regulation of their temperatures. A lever-driven pump is employed to force the cooling-water through the water jackets.

Starting is effected by means of compressed air furnished by an auxiliary apparatus.

224. **French Engines.** Among the more important engines built by the French makers are the *Letombe,* the *Roser-Mazurier,* the *Charon,* the *Gnome,* and the *"Progress"* motor of Lacroix and Company.

225. **The Letombe.** This engine is built in both the single and double-acting types, the latter being of the tandem-cylinder pattern. In the single-cylinder engine built by the same makers and named the *Duplex* motor, the engine is made double-acting by the use of a stuffing box.

In all types, these engines operate on the four-cycle principle, but in the *Duplex* motor the handling of the charge is somewhat modified. Gas and air are first admitted to the back end of the cylinder during the whole of the charging stroke. During the following compression stroke one-half of this charge is transferred through a by-pass to the front end of the cylinder,

and the remainder is compressed and exploded at the end of the stroke. During the compression stroke, the portion of the charge transferred to the front end of the cylinder, amounting to only one-half of the full volume of the cylinder, is necessarily expanded below its normal pressure, but, as the communication to the large connecting passage remains open, the reduction in pressure does not become serious.

The outward power stroke compresses this charge, which is exploded on the return, at the same time exhausting the products of combustion of the charge already exploded in the rear end of the cylinder. Thus, at each revolution, there is both a power and a compression stroke. The volume of the charge used is the same as in the case of a single-acting four-cycle engine, but, as only a half-cylinder full is exploded at a time, and is expanded to the full volume of the cylinder, the ratio of expansion is greater and gives a higher mean effective pressure with the same amount or volume of gas.

It resembles a steam engine, having cross head, guides, etc., and a stuffing box on the crank end of the cylinder. The introduction of the stuffing box does not conform to customary gas-engine practice, but the cylinder head is so thoroughly water-jacketed that no difficulty is experienced with ordinary packing and lubrication.

226. **The Roser-Mazurier Compound Gas Engine.** This engine possesses some original features not usually met with in ordinary gas engines.

As shown by *Fig.* 108, it is of the vertical multi-cylinder type, and consists of three cylinders arranged side by side. The charge is admitted alternately to the two outside cylinders through the valves, A and B, and exploded in the chambers,

C and D, formed by recesses in the pistons. Ignition is effected by means of sparks from a Ruhmkorff coil. The two outside pistons have their cranks in the same line and therefore move together, but the crank of the piston of the larger central cylinder is set opposite the other two. While one of the outside pistons makes its power stroke the other draws in its

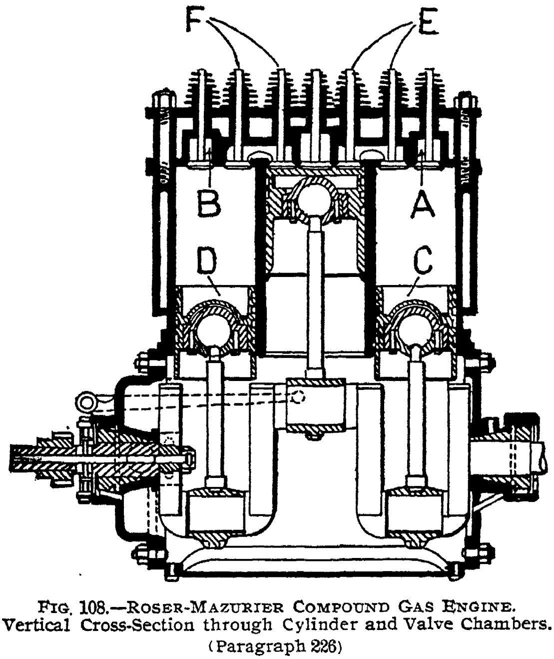

FIG. 108.—ROSER-MAZURIER COMPOUND GAS ENGINE.
Vertical Cross-Section through Cylinder and Valve Chambers.
(Paragraph 226)

charge, so that on every outstroke of the engine either one or the other of the outside pistons makes a power stroke.

At the end of the power stroke of each of the outside pistons, the products of combustion in their respective cylinders are passed through the valves, E and F, into the central cylinder, where their residual pressure becomes expanded to a little above

that of the atmosphere, thus driving the central piston on its power stroke. As the power stroke of this piston occurs during the inward stroke of the outside pistons, the combined action of these three pistons gives the engine two working or power strokes for every revolution of the crank shaft. The cycle of the engine is a unique combination of the essential principles of the four-cycle, two-cycle, and compound methods of operation.

As no combustion takes place in the central cylinder, the water jacket is omitted in this case, the space thus gained being applied to obtain a larger bore with an outer diameter the same as those of the outside water-jacketed cylinders.

The weight of the central piston and reciprocating parts is made equal to the combined weight of the two outside pistons and their reciprocating parts, and as the central mass moves in a direction opposite to that of the two other weights, their momentum and inertia effects are completely balanced.

The shaft center is not in the same place as the cylinder centers, so that the force of the explosions acts upon a lever arm of some magnitude at the very beginning of the power stroke. The idea of this arrangement is that the more rapid movement of the power stroke thus obtained allows less time for the cooling of the expanding gases.

Governing is effected through regulating the amount of gas admitted by a butterfly valve controlled by a centrifugal shaft governor, so that the shaft receives an impulse at each power stroke regardless of the load.

This engine is built in small powers only, and is designed to operate on either gas, or any of the lighter petroleum products.

227. **The Charon.** In this engine a portion of the charge, drawn into the cylinder on the charging stroke, is allowed to escape on the compression stroke into a receiver; the remainder, which is always maintained proportional to the load on the engine by the action of the governor, is compressed and exploded at the end of the stroke, thus giving a greater range of expansion.

This is accomplished by keeping the admission valve open during part of the compression stroke, as determined by the action of the governor.

228. **The Gnome.** This engine is of the inclosed crank-chamber type similar to the Westinghouse. The moving parts run in a bath of oil, and the engine is designed to run at high velocity. It can be operated with either gas or oil, and works on the four-cycle principle.

229. **The "Progress" Motor.** This engine is of the vertical single-acting, four-cycle type, and is designed to operate with gas, gasoline, acetylene, petroleum, naphtha, or alcohol, and requires but slight modifications of the accessory devices to adapt it to each of the different kinds of fuel enumerated.

Fig. 109, shows a vertical section through the crank shaft and cylinder. The suction caused by the descent of the piston draws in air through the valve, A, and, at the same time, the vapor derived from the fuel.

A few drops at a time of the operating medium are forced by a pump, operated by a cam, B, into the vaporizer, located at the top of the cylinder, this being kept at a dull red heat by the temperature of the explosions. On the upward stroke the charge is compressed and ignited by contact with the hot vaporizer.

Governing is effected by means of the centrifugal governor in the fly wheel, which moves the ring, B, and the latching de-

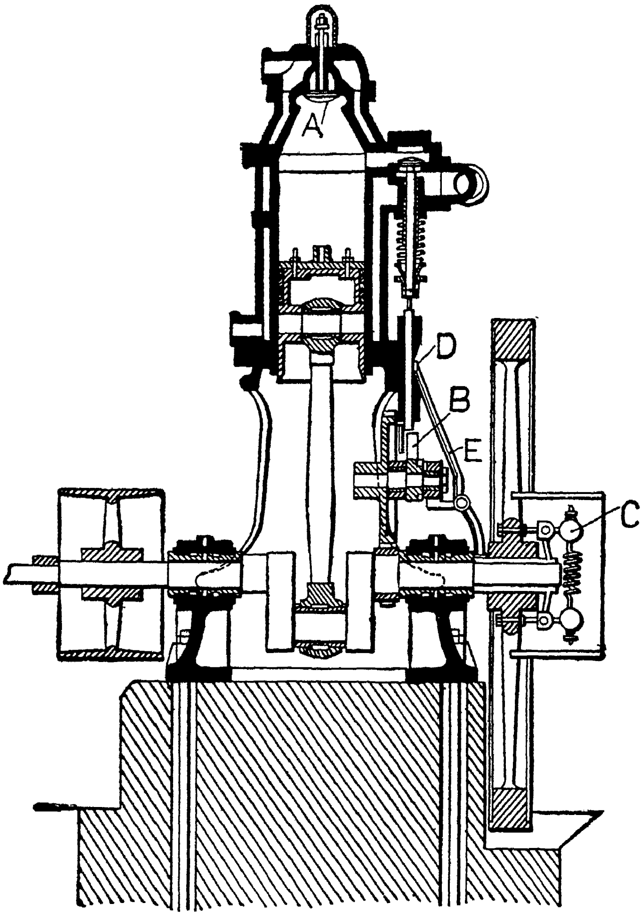

FIG. 109.—LACROIX "PROGRESS" MOTOR.
Vertical Section. (Paragraph 229)

vice, D, through the lever, E. The latching device throws the pump out of action, suspending the injection of oil into the

vaporizer until it is again required to maintain the speed of the engine. The quantity of oil injected by the pump is constant, and the proper mixture for perfect combustion is obtained by the regulated action of the air valve.

The inception and development of the gasoline automobile has been principally due to French inventors and engineers, consequently many of the details of those types of internal combustion motors, suitable for such vehicles, are of French origin. On the other hand, apart from the alcohol motors referred to elsewhere, German engineers have excelled more in the production of large stationary engines using lean gases.

With this trend of development the French have constructed motor boats of exceedingly high speed; one, the *Panhard-Tellier* having attained a speed of 37.3 statute miles an hour. Working in the same direction, other firms have built motors of extremely light weight for aerial navigation, one six-cylinder four-cycle engine by Pelterie developing 35 horse-power with a weight of slightly less than 100 pounds. An eminent builder, Georges Richard-Brasier, has greatly simplified the gasoline motor by fitting a pump feed for the fuel, thus doing away with the carburetter and ensuring equal regulation of the multi-cylinder types of engine now in use.

CHAPTER XX.

OIL ENGINES.

230. Working Principles of Oil Engines. The general principle of operation of oil engines is the same as that of gas engines—the fuel is introduced into the cylinder, is ignited and consumed therein, and the energy thus developed is utilized to drive the piston. Engines using gasoline differ but slightly from gas engines, but those using kerosene or crude oils are often built on very different lines.

231. Gasoline Engines. These machines usually differ from gas engines only in the use of a carburetter and a small pump for forcing the gasoline into it. These devices may be added, however, to any gas engine and thus enable it to use gasoline efficiently.

In the general operation of gasoline engines, it is also possible to use this fuel by injecting it directly into the cylinder, in the form of a liquid, without first passing it through a carburetter, but this method does not give so high a fuel efficiency because the gasoline becomes imperfectly mixed with air, resulting in much slower, and therefore less complete, combustion.

232. Carburetters. A carburetter is a vessel in which the gasoline is vaporized and mixed with air, prior to its introduction into the power cylinder, and the highest fuel efficiency is obtained from the use of such devices as those which will completely saturate the air with gasoline vapor.

These devices may be grouped into three general classes according to their mechanical arrangement and method of operation, as follows:

1. Surface carburetters, in which the air is passed over the

surface of a body of liquid hydrocarbon, or circulated around a gauze, wicking, or metallic surface saturated with such a liquid.

2. Filtering carburetters, in which the air is forced by suction through a body of liquid hydrocarbon, so that it becomes impregnated with some of the substance of the liquid.

3. Float feed carburetters or sprayers, in which the liquid hydrocarbon is discharged, as a fine spray, through a minute nozzle or some form of atomizer, and thus mixed with a passing column of air. See paragraph 249.

233. **The Daimler Carburetter.** The general construction of this device is shown by *Fig.* 110, and its operation may be briefly described as follows:

The gasoline is admitted to the tank, A, through the pipe, B. A float, C, supports a conical chamber, D, in which the level of the gasoline is maintained constant, regardless of variations of the level of the gasoline in the tank. The entering air passes through a jacket around the exhaust pipe of the engine and is thereby heated before reaching the carburetter. Passing through the passage, E, the heated air vaporizes a certain amount of the gasoline in the chamber, D, and then the mixture thus formed passes the baffle plates, F and G, to the admission valve of the engine through the pipe, H. Usually, the admission valve is constructed so as to allow the entrance of fresh air, which mixes with the gasoline-saturated air from the carburetter in the same manner as air and gas are mixed before their introduction into the combustion chamber of a gas engine, but, in the present case, the gasoline vapor being already well mixed with air, the quantity of fresh air admitted at the valve is relatively smaller.

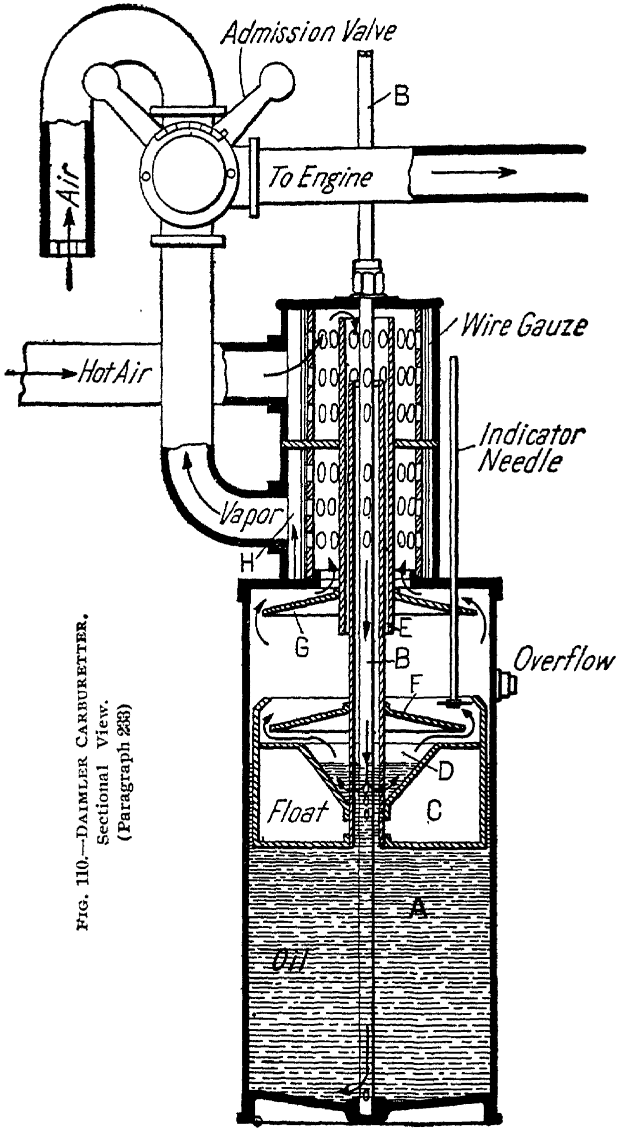

FIG. 110.—DAIMLER CARBURETTER. Sectional View. (Paragraph 233)

As a general rule, carburetters are not quite as complex as this arrangement. Any device, by which gasoline can be vaporized and the air thoroughly saturated with its vapor, will give economical fuel consumption. The simple form shown in *Fig.* 111, operates as follows:

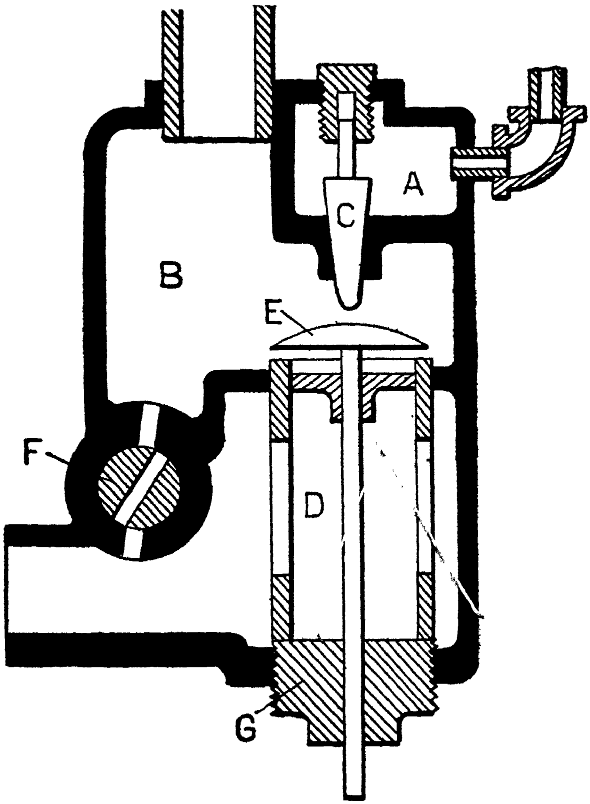

FIG. 111.—SIMPLE FORM of CARBURETTER.
(Paragraph 233.)

From the gasoline chamber, A, the oil is admitted to the mixing chamber, B, through the valve, C, which has a very slight

taper. The valve rod of the engine lifts the valve stem, D, of the valve, E, thus admitting air to the mixing chamber and at the same time opening the valve, C, which delivers gasoline to the mushroom top of the valve, E. The entering air is thus caused to pass through the gasoline which trickles from the rim of the mushroom top of the valve, E, and becomes charged with a portion of its substance. A plug-cock, F, is provided to permit of the dilution of the mixture by an additional quantity of air in the chamber, B. The cage, G, of the valve, D, is adjustable in the casing, and permits of the regulation of the interval of time between the opening of the valves, C and E, so as to produce the best results.

234. **Kerosene Oil Engines.** A gas engine fitted with a carburetter or vaporizer can use kerosene oil without any difficulty whatever, and a great many kerosene oil engines are essentially gas engines with these devices added. The method of fuel-supply usually employed by them consists in spraying the oil, by means of an atomizer, into a hot chamber in which the spray is readily vaporized and mixed with heated air to form the charge for the engine.

On the other hand, there are engines which are especially constructed for the purpose of using kerosene. Such engines are provided with a reservoir, located at a given height above the power cylinder, from which the oil is fed in liquid form into the air admission chamber at the valve opening into the cylinder. Neither carburetters nor vaporizers are used, and the gravity feed renders the use of an oil pump unnecessary.

Another arrangement, commonly used, consists in the addition to the cylinder, of a separate unjacketed combustion chamber, as shown in *Fig.* 116; into this the oil is sprayed immedi-

ately after the completion of the exhaust stroke at the same time that the oil is vaporized by the hot walls of the combustion chamber. On the return stroke, the air is forced into the combustion chamber, and, mixing with the oil vapor, is compressed with it, being ignited at the end of the stroke.

One of the main difficulties encountered in the use of vaporizers in oil engines is due to the fact, that, the process of vaporization requires the raising of the temperature of the oil vapor and the air with which it is mixed to a temperature ranging from 250° to 300° Fahr., at atmospheric pressure. As a result, the specific gravity of the charge is greatly reduced, so that a given volume contains a lesser number of thermal units than when it is at atmospheric temperature, and furthermore, the consequent higher initial temperature results in a higher compression temperature for a given pressure than that attained in the case of a gas engine. The total result is a higher temperature throughout the cycle and a greater loss of heat through the cylinder walls than is the case when the charge is admitted to the cylinder at atmospheric temperature.

The combined effect of these conditions is the imposition of an early limit to the compression ratio, on account of the increased liability to premature ignition due to the higher compression temperature and the lower ignition temperature of the oil vapor, as compared to those involved in the use of coal gas.

Engines which do not use external vaporizers possess the inherent disadvantages of a higher compression pressure accompanied by a lower explosion pressure than those attained by engines of the vaporizer type. This indicates, that for a given size of cylinder and a given quality of fuel, the mean effective

pressure and consequently the power developed will be considerably lower in the former than in the latter.

The following descriptions of some of the standard types of

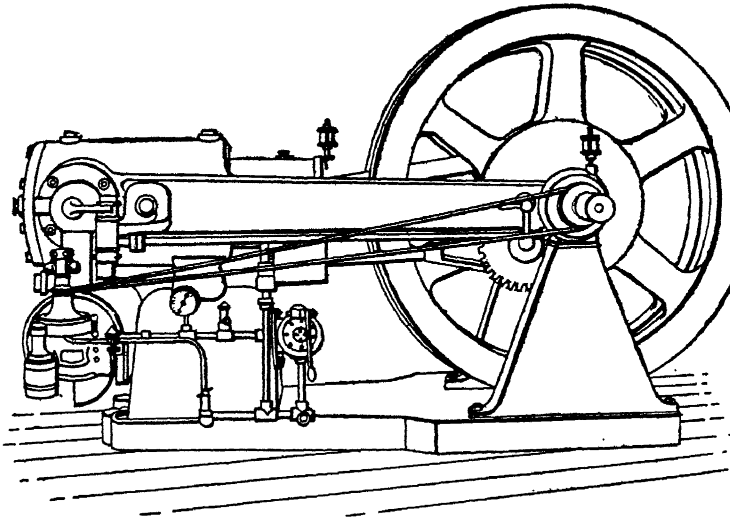

FIG. 112.—PRIESTMAN OIL ENGINE.
(Paragraph 235.)

oil engines will serve to exemplify the various methods and mechanical arrangements adopted by different manufacturers to compensate for the lower efficiencies of oil engines as compared with those of gas engines.

235. **The Priestman.** This engine is designed to operate by ordinary lamp oil.

Fig. 112, shows a general view of the engine, and *Fig.* 113, a cross section through the cylinder, showing the valves and the mechanism of the vaporizing device.

Referring to *Fig.* 112, it will be noted, that two fly wheels are employed, and that both of them, serving as crank-discs, are mounted between the main bearings instead of being placed at each side of the frame in the usual manner. The engine frame

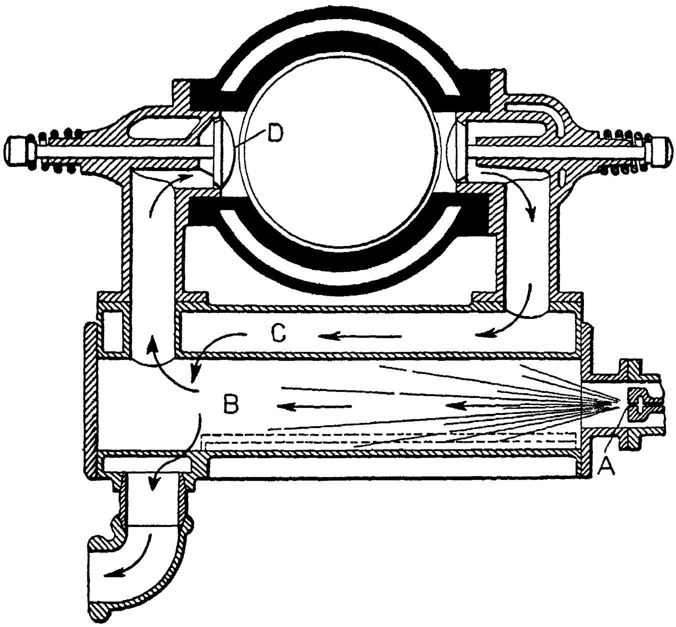

FIG. 113.—PRIESTMAN ENGINE,
Cross-Section through Cylinder, Valve Chambers, and Vaporizer.
(Paragraph 235.)

is bolted to the two forward pedestals supporting the main bearings, and the cylinder rests on the rear pedestal on a ball and socket bearing which is capable of free movement, thus tending to prevent all strains due to expansion and contraction.

The oil reservoir consists of a separate tank which is connected to the engine by three pipes, two of which lead to the up-

per part of the tank, where sufficient space is always maintained above the oil-level for compressed air. An air pressure of five or six pounds is maintained by the pump, located above and in front of the rear pedestal, which is driven by an eccentric from the cam shaft. The oil is lifted to the engine under a running air pressure ranging from 5 to 15 pounds per square inch, according to the size of the engine. The device used for this purpose is shown in *Fig.* 113. A jet of air issuing at a minute nozzle or atomizer, A, converts the oil into a fine spray and injects it into the mixing chamber, B, where it is mixed with free air and heated by the exhaust gases passing through the annular space, C, which constitutes the heater.

Before starting, it is necessary to heat the mixing chamber, with lamps provided for that purpose, in order to prevent the oil spray from condensing on the cold walls, but after the engine is once started, the heat furnished by the exhaust gases is sufficient for this purpose. All engines except those of the smallest size are equipped with self-starters, which are operated by compressed air supplied by a hand pump furnished with the engine, or from a special air tank in which the compressed air has been previously stored by the automatic pump.

The ignition is electric, the jump-spark being used, and the governing is effected by the throttling method, the governor lowering a spindle into the oil pipe and thus reducing the quantity of oil admitted to the atomizer, while at the same time it reduces the quantity of free air admitted to the engine, through a separate valve, for burning the oil. The inlet valve, D, opens under the external pressure of the atmosphere.

No separate device is employed for lubricating the cylinder, as a portion of the oil spray, used as fuel, coats the cylinder walls and furnishes all the oil necessary for proper lubrication.

236. The Meitz and Weiss. This engine is of comparatively simple construction, operating on the two-cycle principle; and has no igniting apparatus to require attention and cleaning.

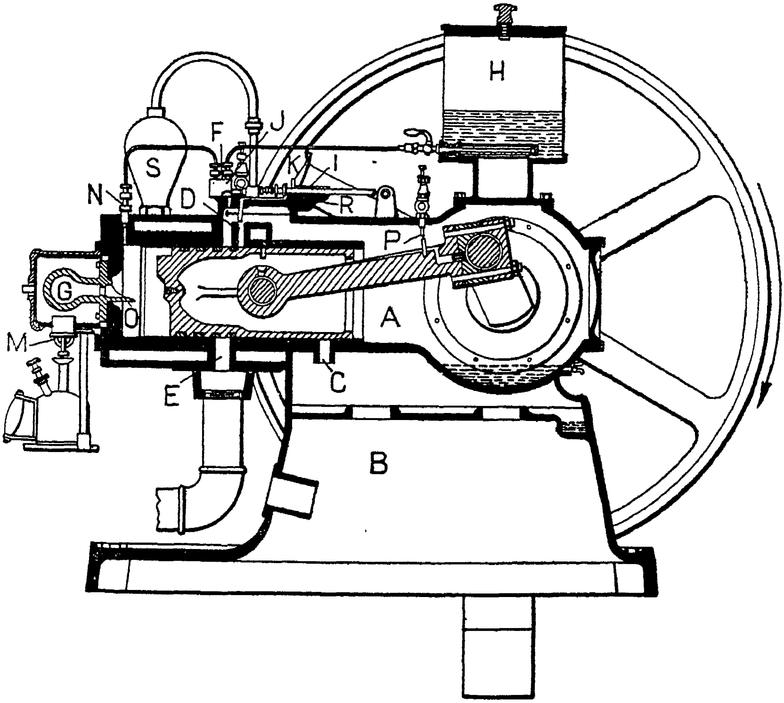

FIG. 114.—MEITZ AND WEISS OIL ENGINE.
Longitudinal Section.
(Paragraph 236.)

Referring to *Fig.* 114, which shows a longitudinal section of the engine, its operation may be briefly explained as follows:

Air is drawn into the closed crank chamber, A, from the interior of the base, B, through the port, C, in the lower part of the cylinder. On the outstroke of the piston, this air is com-

pressed, and the opening of a port, D, by the piston, allows the air, together with the steam generated in the water jacket, to pass into the combustion space of the cylinder. At the same time, the exhaust port, E, having been overrun, and thus opened by the piston, discharges the products of combustion of the previous charge into the exhaust pipe.

The fuel is injected into the cylinder by the pump, F, and mixes with the air and steam previously admitted from the crank chamber, so that on the instroke, or compression stroke proper of the piston, the charge is automatically ignited by contact with the heated walls of the igniter ball, G.

Oil storage tanks capable of holding more than a barrel are placed underground and the engine provided with a small pump to supply the reservoir, H. In most cases, the suction pipe of the injector pump, F, can be connected directly to the storage tank, or to a small tank placed on the floor or on the engine.

The oil pump is of the single-acting plunger type, the suction and pressure checks being screwed into the pump body. A small lever serves to operate it by hand in starting the engine, and to draw the oil in case the pipes are not completely filled. During continuous running, it is operated by a rocker arm connected to the eccentric through the plunger guide, I. The spring around the plunger, L, forces it back to the short spring stop of the guide.

To stop the engine, the pump lever is pulled back while a pressure is exerted on the small projecting pin, K, at the side to lock the plunger guide out of action.

Ignition is effected by means of a hollow cast iron ball, G, located in the projection attached to the cylinder head. A charge is formed at every revolution of the crank shaft and com-

pressed by the piston into the compression space of the cylinder and the interior of the igniter ball, where it is promptly ignited when the piston reaches the dead point. Before starting, the igniter ball is heated for a few minutes by a small oil burner, M. The oil jet from the injection nozzle, N, strikes the pro-

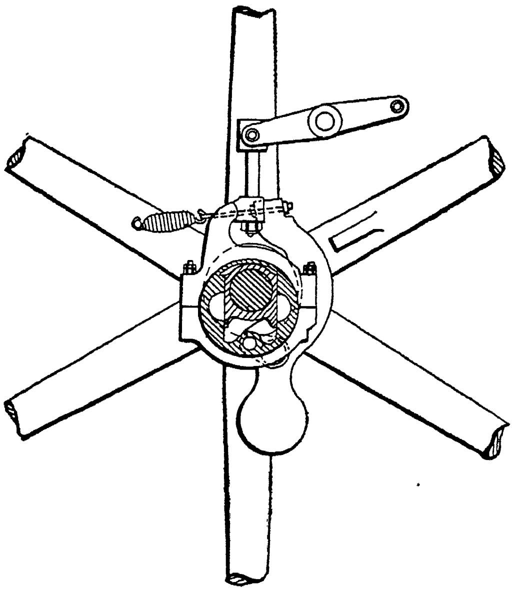

FIG. 115.—MEITZ AND WEISS ENGINE.
Governor.
(Paragraph 236.)

jection, O, extending from the igniter ball and is sprayed, vaporized and mixed with the air and steam in the compression space. The igniter ball is maintained at a dull red heat by the heat of the explosions.

The governor is of the centrifugal type, pivoted to the fly wheel, and is adapted to control the action of the pump plunger. As shown in *Fig.* 115, it consists of a movable eccentric connected to a spring-controlled weight, the centrifugal force of which acts against the spring, shifts the eccentric across the shaft, and results in a shorter stroke of the pump, and consequently the injection of a smaller quantity of oil into the cylinder at each stroke. The movement of the weight is limited by two stops, one on a spoke and the other at the hub of the fly wheel.

The crank and piston are lubricated from an oil well, screwed to the side of the cylinder and connected to adjustable sight feeds. The well being located below the point of feed, the oil is drawn through the sight feeds by suction when the engine is in operation. The crank case sight feed is provided with a projecting tube, P, *Fig.* 114, which feeds the oil directly to the pin in the groove of the connecting rod. The accumulation of oil in the bottom of the crank case furnishes sufficient splash lubrication for the front part of the piston, the main bearing washers, and the piston pin. The cylinder sight-feed is screwed into the pump plate, R, and communicates with the air port of the crank case through a hole drilled across the plate. A tube screwed into the pump plate enters the cylinder oil-hole leading to the top of the piston and the wrist pin.

The cylinder is water-jacketed, and the cooling water supply may be taken directly from the mains or from a tank. The supply pipe is connected to a float box valve, and the water must be under sufficient pressure to run into the jacket of the cylinder. The float keeps the water in the box and that in the water jacket at a constant level, so that the upper gauge cock on the float box shows steam and the lower cock shows water. The

heat of the cylinder generates steam which passes through the dome, S, to the air port communicating with the crank case, and thence, together with the air admitted to the crank case, to the combustion space of the cylinder, where it is mixed with the vaporized oil and forms the charge.

All engines above 30 horse-power are provided with a self-starter consisting of either a hand or belt driven pump and a suitable air tank.

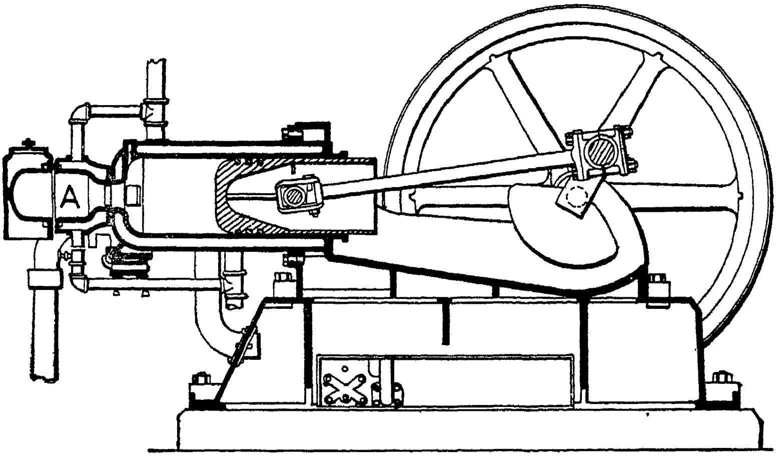

FIG. 116.—HORNSBY-AKROYD OIL ENGINE.
Longitudinal Section.
(Paragraph 237.)

237. **The Hornsby-Akroyd.** This engine operates on the four-cycle principle. The fuel, which may be either kerosene or crude petroleum, is injected and volatilized directly in the bottle-shaped vaporizer. Ignition is effected by the compression of the charge in the combustion chamber, which being partly or entirely without a water jacket, remains at a dull red heat and ignites the charge just as the crank passes the inner dead point.

Fig. 116, shows a longitudinal section of the engine, and *Fig.* 117, a longitudinal section through the valves.

The timing of the ignition is perfectly controlled by the length and diameter of the bottle-neck connecting the vaporizer with the combustion space of the cylinder. The explosion of the charge takes place entirely within the vaporizer, the piston being protected by a layer of pure air, drawn into the clearance space; this is proved by the absence of tarry gummy matter on the piston rings.

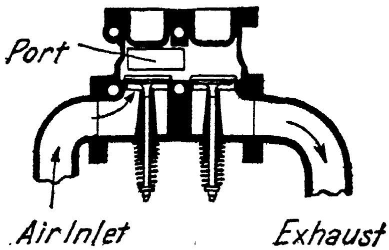

FIG. 117.—HORNSBY-AKROYD ENGINE.
Longitudinal Section through Valves.
(Paragraph 237.)

Governing is accomplished by allowing a greater or lesser amount of the oil, displaced by a positively-driven pump-piston, to flow back to the oil reservoir, usually located in the base plate of the engine. This is effected by means of a governor which opens a by-pass when the speed of the engine temporarily increases. If the engine is required to run for any considerable length of time under less than full load, the stroke of the pump can be readily adjusted to the load carried by the engine.

In starting, it is advisable first to light the Bunsen burner used for heating the vaporizer and place it on a stand of proper

height just beneath the latter; the vaporizer being protected from the cooling effect of air currents by a movable hood. While the vaporizer is being heated, the oil cups may be filled and the cam-lever shifted to the position for starting. When this is done, the smaller engines can be turned over by hand.

Engines above 25 horse-power are provided with a self-starting device, operated by compressed air, on opening the valves between the receiver and the engine, and putting the starting lever into the charging position, the engine itself being used to pump a pressure of 80 to 100 pounds in the starting tank.

Both the air inlet and the exhaust valves are placed on the side of the cylinder, the former being operated by suction or atmospheric pressure, and the latter by means of worm gearing on the secondary shaft. The secondary shaft also operates the oil pump which injects the fuel oil into the combustion chamber.

This engine is principally made in the horizontal type, with single or twin cylinders. In the United States it is constructed by the De La Vergne Machine Co., in sizes ranging from 1½ to 125 horse-power per cylinder; and in England as large as 500 horse-power per cylinder.

238. **The American Diesel.** As stated in paragraph 65, this engine is designed to operate on solid, liquid, or gaseous fuel, but up to the present time it has been chiefly developed as an oil engine.

Fig. 118, shows a vertical section through the crank case and cylinder, and *Fig.* 119, a section through the fuel, air, and exhaust valves.

Referring to *Fig.* 118, the operation of the engine may be described as follows:

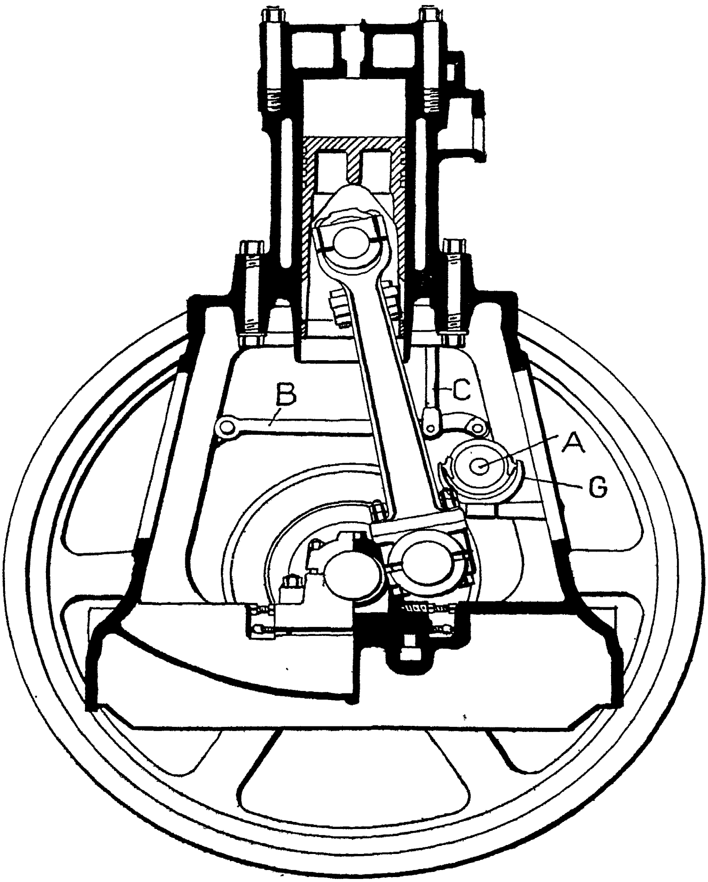

Fig. 118.—American Diesel Engine.
Vertical Section through Crank Case and Cylinder.
(Paragraph 238)

Through gearing, the main shaft drives a cam shaft, A, which carries the valve cams and is supported by end bearings in the engine housing. Two cams operate the admission and exhaust valves by means of nearly horizontal arms, B, pivoted at one end to the housing, and carrying rollers which are in contact with the cams. These arms are held down by springs, and the vertical valve rods, C, rest upon and are moved by them.

The compressed air, from the auxiliary compressor, comes through the pipe, D, *Fig.* 119, into the same space but behind the oil delivered from the oil pump through a pipe at the side.

The valve spindle is surrounded by a series of brass washers which are perforated with numerous holes parallel to the axis of the spindle. The oil occupies the cavities between these washers, and by capillary action finds its way into the perforations. When the fuel valve is opened, the compressed air drives this oil out, through the perforations, in the form of a fine spray, into the cylinder where it is instantaneously ignited by the high temperature of the air compressed into the clearance space by the upstroke of the piston.

The clearance space is only about 7 per cent. of the cylinder volume, so that the air for combustion drawn into the cylinder through the poppet valve, E, is compressed on the upstroke of the piston to a pressure ranging from 450 to 525 pounds per square inch, with an accompanying compression temperature of about 1000° Fahr., which is much more than sufficient to ignite the oil the instant it is injected into the cylinder.

At the beginning of the power stroke, the fuel valve opens and remains open for about a tenth of the stroke, and the combustion of the oil admitted continues during the whole or a portion of this period according to the action of the governor. After

the fuel supply is cut off, the working substance, air, expands adiabatically during the remainder of the stroke, until the products of combustion are discharged from the cylinder by the opening of the exhaust valve, F, the terminal pressure being but slightly greater than that of the atmosphere.

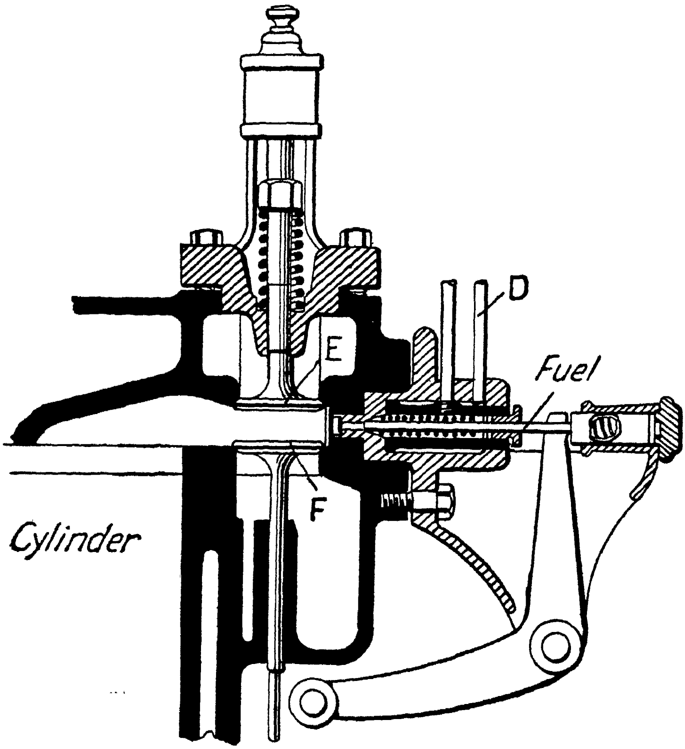

FIG. 119.—AMERICAN DIESEL ENGINE.
Section through Fuel, Air, and Exhaust Valves.
(Paragraph 238)

Governing is accomplished by regulating the quantity of oil fed to the fuel valve during each stroke by means of an oil pump driven from the cam shaft. In the multi-cylinder en-

gines, each power cylinder is provided with a separate pump cylinder, and a valve, which, when open, acts as a by-pass and permits the oil to return to the suction side of the pump instead of flowing to the fuel valve of the engine. The by-pass valves are kept open by the action of the governor during a greater or lesser part of each stroke according to the load on the engine. These valves are opened by arms, pivoted at one end on a shaft which is raised or lowered by the governor, deriving their motion from rods connected to eccentrics on the pump driving shaft. The short link from the governor collar to the crank on the shaft carrying the valve opening arms, transmits the motion of the governor to the shaft, thus raising or lowering the shaft so as to increase or decrease the distance between the top of the by-pass valve rods and the arms which open the valves. By this arrangement, the interval of time during which the oil valve remains open, and consequently the quantity of oil pumped to the admission valves of the cylinders, depends on the relative distance between the top of each valve rod and its corresponding opening arm, as determined by the action of the governor. The admission valve, however, always remains open a constant length of time regardless of the action of the governor, but, except at full load, fuel is fed into the cylinder during a part only of the time the valve is open, the commencement of the expansion curve on the indicator diagram marking the time when the fuel supply is interrupted. Compressed air alone, blows by the valve during the remainder of the time it is open.

The cylinder walls, cylinder heads, and all valves are water-cooled. The pistons are very long, the connecting rods of the marine type, and the main bearings are adjustable by wedges and screws.

The lubrication is automatic. The massive housing entirely incloses the reciprocating parts, and is provided with removable doors in the side giving easy access to the interior for purposes of adjustment and repair.

Starting is effected by means of compressed air furnished by an auxiliary reservoir. A handle outside the housing throws

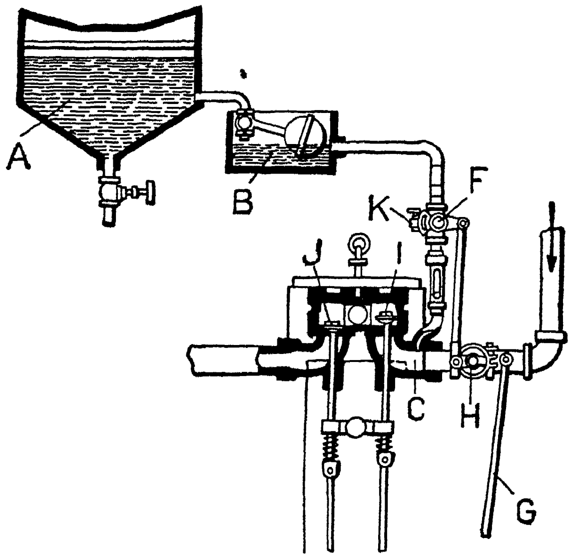

FIG. 120.—SECOR OIL ENGINE.
Gravity Feed Arrangement.
(Paragraph 239)

the fork, G, *Fig.* 118, so as to move the valve cams of the first cylinder along the cam shaft, and bring into action a starting cam which operates a starting valve. This valve merely admits compressed air into that cylinder, for one or two revolutions, until the compression in the other cylinders is sufficient to ignite their charges. The handle is then released, so that, while

the starting cam is thrown out of action, the admission and exhaust cams of the first cylinder are again thrown into action.

This engine is built in the vertical, single or multi-cylinder types in sizes ranging from 75 to 450 horse-power.

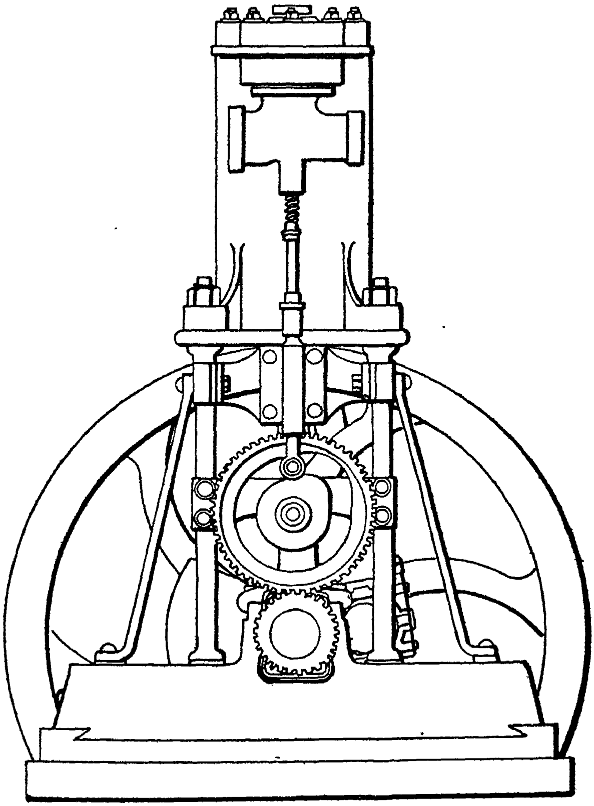

FIG. 121.—SECOR OIL ENGINE.
Side Elevation. (Paragraph 239)

239. **The Secor.** This engine has neither atomizer nor vaporizer, nor does it use any pumping device for injecting the oil into the cylinder. A gravity feed is employed to maintain

a constant level of the oil supply above the cylinder by means of a float, as shown in *Fig.* 120. The main reservoir, A, supplies oil to the tank, B, in which the float valve is mounted.

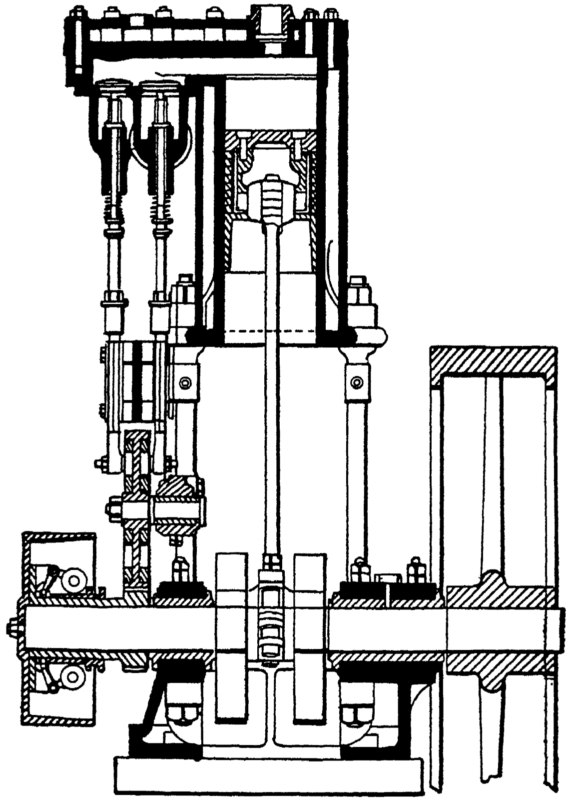

FIG. 122.—SECOR OIL ENGINE.
Vertical Cross Section through Cylinder and Valve Chambers.
(Paragraph 239)

The oil is delivered by gravity from the tank, B, to the inlet pipe, C, passing through the regulating cock, F, the opening of which is controlled by the governor through the rod, G, which

also controls the volume of air admitted by operating the air cock, H. Both the admission valve, I, and the exhaust valve, J, are operated by cams on the secondary shaft in the usual manner. The proportion of air to oil is regulated by means of a micrometer worm at K, which shifts the fuel valve, F, with respect to the valve lever actuated by the governor. By this arrangement, it is possible to vary the quality of the mixture forming the charge, according to the grade of oil used, while, on the other hand, when the adjustment at K, is once made, the proportion of air to oil remains constant, regardless of variations in the load, and the consequent throttling of the charge by the governor.

Ignition is effected by the jump-spark method, with primary batteries supplying the current for the spark coil.

Fig. 121, shows a side elevation of the engine, and *Fig.* 122, a vertical section through the cylinder, valve chambers, and crank shaft.

CHAPTER XXI.

MARINE ENGINES.

240. Marine Terms. The *"bow"* is the extreme forward part of the vessel. The *"stern"* is the extreme after part of the vessel. *"Amidships"* is the central part of the vessel. *"Forward"* is the part between amidships and the bow. *"Aft"* is the part between amidships and the stern. *"Starboard"* is the right hand side of the vessel looking forward. *"Port"* is the left hand side of the vessel looking forward.

241. Working Principles of Marine Engines. The various types of gas, gasoline, and oil engines used for marine purposes operate on the four-cycle or the two-cycle principle, as explained in Chapter IV, and are usually of the vertical single or multi-cylinder, and single or double-acting type.

In the general arrangement and construction, they very closely resemble corresponding types of automobile motors, but they are made very much heavier so as to enable them to withstand the wear and tear incident to continuous operation under full power, a service seldom required of the automobile engine.

They are being built in sizes ranging from 1 to 1,000 horse-power,—the 1 to 20 horse-power engines being suitable for various types of motor boats, the 20 to 100 or more horse-power for launches and small yachts, and the larger sizes for torpedo boats, destroyers, small cruisers, tugs, and ferryboats in the naval service.

In the last named cases, the successful introduction of suitable gas producer systems is one of the assured features of the developments in this line in the immediate future.

At the present time, the demand for motor boats, launches and small cruising yachts, propelled by internal combustion engines, is increasing at a rapid rate, and is accompanied by a demand for larger engines. In the case of the smaller sizes, the simplicity of construction, and the reduction in the number of working parts, tend to make these engines practically automatic in their action, so much so, that they may be readily handled by any one who has received brief but specific instruction as to their operation. Nevertheless, it is also true, that like those of the larger sizes their successful and continuous operation largely depends upon their proper management.

It is well to understand in this connection, that the relative merits of the two types of engines,—the four-cycle and the two-cycle, is one of the questions relative to internal combustion engines which still remains practically undecided. A great deal can be said in favor of and against each type, on both theoretical and practical grounds, but as the majority of engineers do not appear to be quite unanimous in their methods of computing mechanical efficiency, it is very difficult if not impracticable to make a decisive comparison of the two types just at the present stage of their development. It is quite probable that engines of either type built by the best manufacturers will give equally satisfactory service under general working conditions.

242. **Essential Requirements of a Marine Engine.** The most extended experience and careful observation indicate the following named requirements as essential for the successful operation of a marine internal combustion engine:

1. They should be capable of being easily started, readily controlled and quickly reversed.

2. Small sizes may be either single or double-acting. Large sizes ought to be double-acting. All engines ought to be of the vertical type.

3. They ought to be provided with reliable governors, preferably of the throttling type, which will prevent them from racing in a seaway or when reversing.

4. Every part of the engine exposed to heat should be amply water-jacketed, and suitable means should be provided for maintaining the temperature of the cooling water within a few degrees of the highest point necessary for effective lubrication.

5. All governors, cams, and other working parts should be inclosed to prevent rattling noises, and all valves should be inclosed in sound-deadening pockets.

6. All engines should be provided with properly constructed mufflers to deaden the objectionable noises caused by the explosions and the exhaust.

7. The engine should be properly balanced, and equipped with very heavy fly wheels to prevent vibration.

8. The ignition should be electric, starting being effected by battery current, and subsequently by spark furnished by a sparking magneto.

9. The gasoline should be stored in a strong copper tank, well braced and divided by partitions to prevent washing about.

10. The engines should be provided with carburetters of the float-feed type which will generate the proper mixture of gasoline vapor and air under all conditions regardless of the speed of the vessel, and maintain a constant level of gasoline regardless of the pitching of the vessel in a heavy seaway.

11. All engines should be equipped with reversing gear of the friction clutch type operated by means of a single lever.

The gears should always be in mesh so as to prevent sudden jars when reversing quickly.

12. The bore of the cylinder should be about equal to the stroke of the piston.

243. **Working Parts of a Marine Engine.** The essential parts of a marine internal combustion engine are practically the same as those of corresponding types of stationary engines, but suitably modified to meet the demands of their particular service. The details of construction vary more or less in the different makes, to such an extent, that it is practically impossible to formulate a general description, which will be applicable to all with respect to the detailed arrangement of their minor working parts. It is practicable, however, to give a general description of the principal working parts of a two-cycle marine engine, which, when taken in connection with the subject matter of Chapter IV, relative to the operation of four-cycle engines, and the brief descriptions of some of the standard makes of marine gasoline and oil engines given in this chapter, will afford a comprehensive knowledge of the construction, peculiarities, and methods of operation of the various types of marine engines in general.

244. **Principle of Operation of a Two-cycle Marine Engine.** Referring to *Figs.* 123 and 124, showing vertical transverse cross sections through the cylinder and crank case of a two-cycle engine, and *Fig.* 125, showing a longitudinal section through the crank shaft, the operation of the engine may be described as follows:

The suction caused by the upstroke of the piston, A, draws a charge of vaporized gasoline and air through the vaporizer inlet, B, into the interior of the crank case or crank chamber,

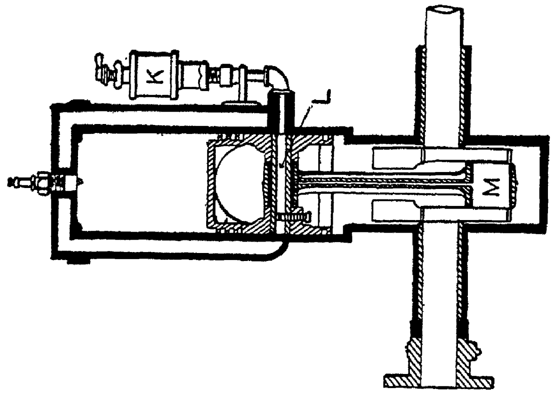

FIG. 125.

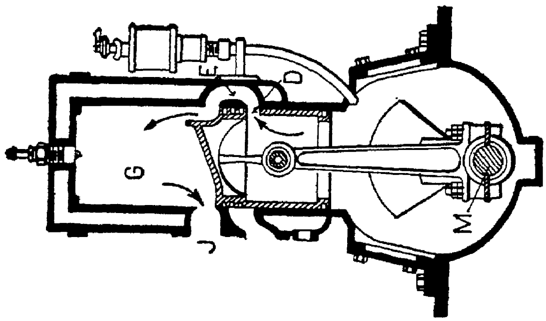

FIG. 124.

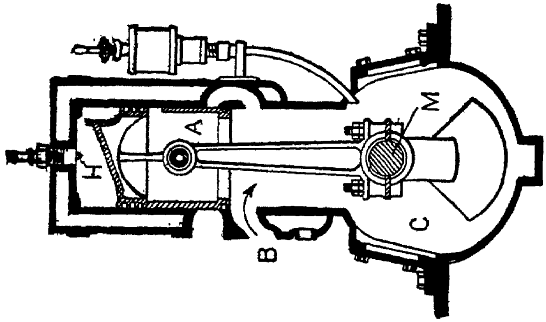

FIG. 123.

PRINCIPLE OF OPERATION OF A TWO-CYCLE MARINE ENGINE.
(Paragraph 244)

C, *Fig.* 123. This charge is compressed in the crank chamber by the following downstroke, and as the piston reaches the lower limit of this stroke, it brings the admission port, D, opening into the hollow of the piston, opposite the by-pass, E, *Fig.* 124, communicating with the crank chamber, thus permitting the charge in the crank chamber to pass into the combustion space, G, of the cylinder.

The next upstroke of the piston compresses the charge into the compression space at the top of the cylinder where it is ignited by a spark at the lower end of the spark plug, H, *Fig.* 123. The force of the resulting explosion drives the piston downwards on its power stroke, and as the piston passes the exhaust port, J, *Fig.* 124, the products of combustion are exhausted from the cylinder; a fresh charge, compressed into the crank chamber by this stroke, is again allowed to pass through the port, D, and the by-pass, E, into the combustion space, G. The momentum of the fly-wheel then carries the piston upwards on another compression stroke, so that the entire cycle of operations is repeated, giving a power stroke at every revolution of the crank shaft.

The method of lubrication is illustrated by *Fig.* 125. In the case of the crosshead, piston, and cylinder walls, the lubricating oil is carried directly from the cylinder lubricator, K, through the passage, L, in the hollow piston pin; and in the case of the crank-pin, M, the revolving crank-pin connections take up the oil fed into the crank chamber through the pipe leading from a separate sight feed lubricator placed on the crank chamber.

245. **Fairbanks Marine Gasoline Engine.** These engines are built in the vertical single or multi-cylinder type and operate on the two-cycle principle.

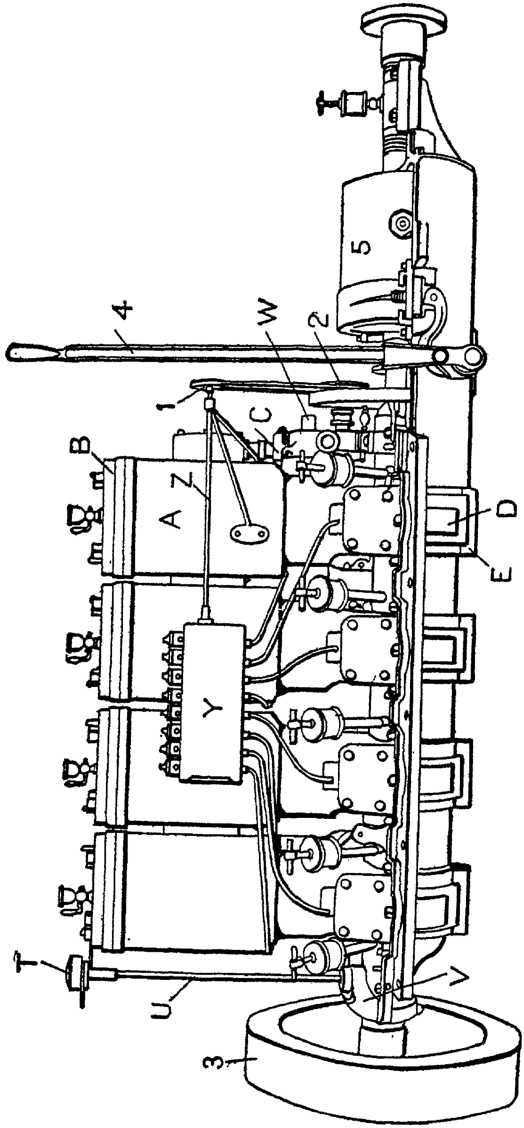

Fig. 126.—Fairbanks Gasoline Marine Engine; Port Side.
(Paragraph 245)

Fig. 126, shows the port side, and *Fig.* 127, the starboard side of the four-cylinder 28-35 horse-power engine, and *Fig.* 128, a vertical section through one of the cylinders.

Referring to Fig. 126, the cylinder, A, the cylinder head, B, and crank case, C, constitute the principal castings. The cylinder proper is a separate casting from the bed plate, and when attached to the latter forms the crank case. The two halves of the crank case are put together and held in alignment by means of steel dowels, and each crank case is provided with hand holes, D, which admit of easy access to the crank connections. The lower part of the crank case terminates in a pocket, E, provided for catching small particles of dirt or grit, which together with surplus or dirty oil can be drawn off by means of a small brass drain cock. The cylinder casting, cylinder head, exhaust pipe casting, and the gas inlet pipe, G, *Fig.* 127, are all completely water-jacketed. The cylinder head is secured to the cylinder by means of steel studs and case hardened nuts, and two small lifting screws are attached to each head by which they can be lifted away from the cylinder whenever necessary, without the use of wedges which scar the castings and break the gaskets.

The piston, H, as shown in *Fig.* 128, has an oblique upper surface which serves to sweep out the products of combustion while the piston admission port, I, when opposite the by-pass, J, permits of the quick entry of the fuel gas into the combustion chamber, K.

The passage of the cool fresh charge through the hollow piston not only tends to reduce the temperature around the piston pin, L, but lowers the temperature of the entire surface of the piston to a point sufficiently low for effective lubrication. Each piston is provided with four piston rings, M, three at the

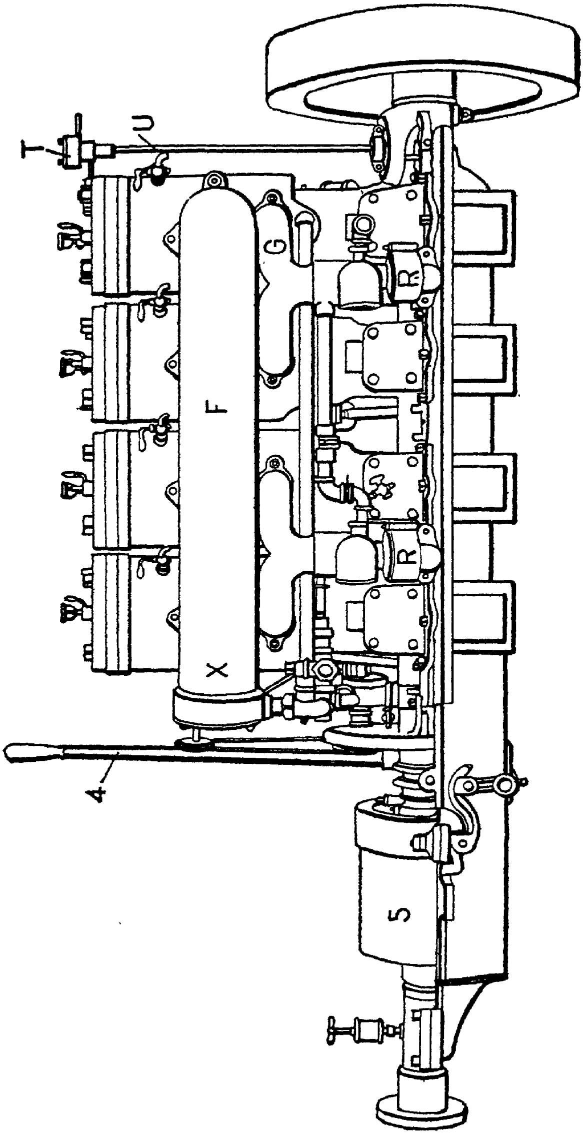

FIG. 127.—FAIRBANKS GASOLINE MARINE ENGINE; STARBOARD SIDE.
(Paragraph 245)

top and one at the bottom, carefully ground and fitted to a fraction of one-thousandth of an inch. The piston pin, L, is of hardened steel. It is hollow, and thereby provides the oil passage for the lubrication of the piston, cylinder walls, and its own bearing.

The connecting rod, N, is made of forged steel, and is designed to give the greatest possible strength without adding materially to the total weight of the reciprocating parts. The piston pin bearing is an interchangeable bushing of phosphor bronze, and the bearing on the crank pin is made of Babbitt metal. The crank pin connection, O, is secured by stud bolts with nut and lock nuts, the latter being secured by steel split pins, and afford the means for taking up wear due to continuous service.

The crank shaft is forged from a solid ingot of high carbon steel, turned and ground accurately to size. All cranks are provided with counter balances as shown at, Q.

These engines will operate successfully on any grade of gasoline from 62 to 88 degrees Beaumé, and will consume from 1 pint to 1⅓ pints per horse-power-hour.

They are equipped with carburetters, R, *Fig.* 127, of the float-feed type, provided with a throttling lever by means of which the speed can be quickly and easily regulated.

Ignition is by jump-spark, the principal parts of the electrical equipment being a battery, either dry or storage, a vibrator or spark coil, timer, spark plugs, S, *Fig.* 128, switch and wire.

The jump-spark coils are of the dashboard type used on the better classes of automobiles. In each case the coil is covered with insulating material which is unaffected by variations of temperature, and the entire arrangement is placed in a box

having a close fitting cover which protects the electrical parts from contact with dirt and water.

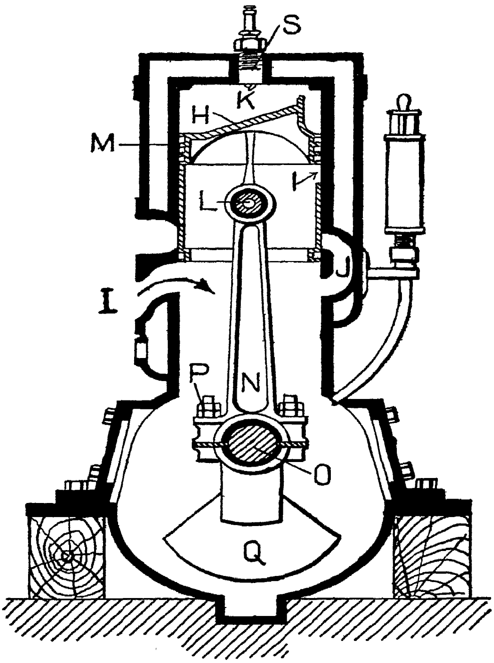

FIG. 128.—FAIRBANKS GASOLINE MARINE ENGINE.
Vertical Section through one Cylinder.
(Paragraph 245)

The timer, T, *Figs.* 126 and 127, is of the rotary type and consists of a hard-rubber case containing the contact points,—two hardened steel balls placed one above the other. Operating

between these balls is a steel knife or cam mounted on ball bearings. The cam is actuated by a bronze shaft, U, driven by bevel wheels incased in a brass gear case, V, located above the crank shaft directly aft of the fly wheel. A friction lever attached to the timer case permits the regulation of the spark for all cylinders.

The spark plugs are of the porcelain insulated type, and are provided with separate terminals for connecting the secondary wire to the plug. These terminals are of the clip pattern, and may be removed for examination by unscrewing the brass bushing only, which at once releases the whole plug, with the exception of the shell, from the cylinder. The spark plugs are completely covered with porcelain hoods which protect them from heavy rain or seawater if the engine is used in an open boat. Each hood has a neck, one side of which is recessed for the introduction of the clip terminal, which engages the slot of the brass cap of the spark plug. A piece of rubber tubing covers a portion of the insulation of the secondary wire and ferrule end of the terminal. It is of sufficient length to be stretched over the neck of the hood, thus making a perfectly watertight connection. The entire arrangement carries the insulation from the wire down over the spark plug to the cylinder head, and thus obviates all possibility of short circuiting. This device is unnecessary on engines placed under cover.

On the single cylinder engines, the cooling water is pumped by means of plunger pumps operated by the eccentric rods. The multi-cylinder engines employ a rotary pump, W, *Fig.* 126, especially adapted for pumping dirty water, and driven by two brass spur wheels directly from the end of the crank shaft. The pump is equipped with a three-way cock which gives it the double capacity of a bilge pump and a seawater pump.

By turning this cock in one direction the water supply is drawn from the sea, and by turning it in the opposite direction the bilge water can be pumped out of the boat. Drain cocks fitted to the lower part of the cylinders and the water-cooled exhaust pipe connections, X, permit the drawing of the water from the water jackets, piping, and pumps, in freezing weather.

The cylinder and crank case lubricators are of the sight feed type. The multi-cylinder engines are equipped with a force-feed oiler and oil reservoir, Y, carrying on its top the sight feed glasses which enable the operator to see the amount of oil that is being fed to any particular bearing. Adjusting screws are attached to the top of the reservoir, by means of which the flow of oil to the bearings can be individually regulated. The action of the oiler depends upon that of the shaft, Z, which leads to the reservoir and operates a series of small pumps which force the oil directly to the bearings. The shaft is operated by the belt-driven pulleys 1 and 2, *Fig.* 126, operated from the crank shaft, thus giving an automatic delivery of oil in proportion to the speed, and a cessation of oiling when the engine stops.

Starting is effected by turning the fly wheel, 3, *Fig.* 126, by hand, cranking being unnecessary. The larger engines are, however, provided with a ratchet turning gear, so as to overcome the higher compression. After starting, the speed is regulated by automatic action of the carburetter and the spark control.

The noise of the exhaust is deadened by means of a muffler of the injector type.

When a solid bladed propeller is used, reversing is accomplished by means of a reversing lever, 4, *Fig.* 126, which operates the gearing and friction clutch mechanism shown at,

5. The clutch is directly connected and always remains in perfect alignment, the wheels revolving idly with the shaft when going ahead. For backing, the reversing lever is thrown so as to release the clutch, and a reversed motion is imparted to the propeller through the bevel gearing.

246. The Meitz and Weiss Marine Engine. In general construction and operation, this engine is similar to the stationary engines built by the same manufacturers and described in paragraph 236, and operates with kerosene, distillate, residuum or crude oil. It is of the vertical single or multi-cylinder type, and is built in sizes ranging from 1½ to 100 horse-power.

Fig. 129, shows the starboard, and *Fig.* 130, the port side of a two-cylinder engine, and *Fig.* 131, a vertical section through one of the cylinders.

All the principal stationary and working parts of the engine are lettered and named on the figures, and, as already stated, the principle of operation is exactly similar to the stationary horizontal engines described in paragraph 236.

To start the engine, unscrew the funnel cap of the burner cylinder, E, *Fig.* 130, open the gauge cock, 6, *Fig.* 131, and fill the vessel three-quarters full through the filler, R, *Fig.* 131, until oil runs out of the gauge cock. Pump up the compressed air tank, turn on the air valve, and light the burner with the torch furnished for that purpose. Regulate the air pressure by means of the needle valve so as to obtain a strong but short flame. Five minutes is usually sufficient to bring the igniter ball to a dull red heat. In the case of a multi-cylinder engine, this operation must be performed in connection with each cylinder.

When the igniter balls have attained the proper temperature, open the relief cocks, M, *Fig.* 129, on the compression chambers of the cylinders, and turn the fly wheel over until the handle is opposite the governor gear; close the relief cocks; open the throttle about two-thirds; pump one or two charges of oil into the cylinders by pressing quickly down on the pump

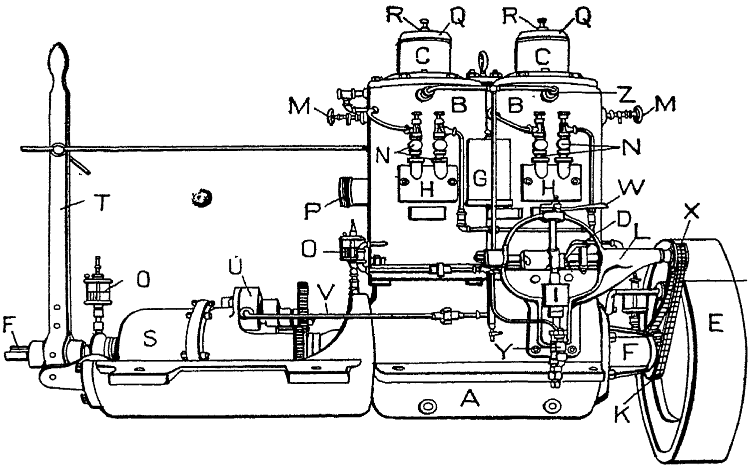

FIG. 129.—MEITZ AND WEISS ENGINE; Starboard Side.
(Paragraph 246)

A—Crank Case.
B—Cylinder.
C—Mantle.
D—Governor Weight.
E—Flywheel
F—Crank Shaft
G—Lubricator Oil Reservoir.
H—Port Covering Plate.
I—Oil Supply Pump.
J—Governor Chain.
K—Governor Chain Gear.
L—Governor Bracket.
M—Relief Cocks.
N—Sight-Feed Lubricators.
O—Lubricator Oil Wells.
P—Exhaust Fitting.
Q—Dampers.
R—Damper Screw Holders.
S—Reversing Gear.
T—Reversing Lever.
U—Circulating Water Pump.
V—Circulating Water Pipe Connection.
W—Oil Pump Handle.
X—Idler Bracket.
Y—Suction and Pressure Valves.
Z—Injection Pipe.

handle, W, *Fig.* 129, then rock the fly wheel a few times to the right against the compression until an explosion is obtained which will drive the piston forward.

After the engine has been started, the throttle can be opened wide so as to allow it to attain full speed.

Should the engine start backwards, hold the pump lever down until it slows down, then forcibly inject a charge of oil

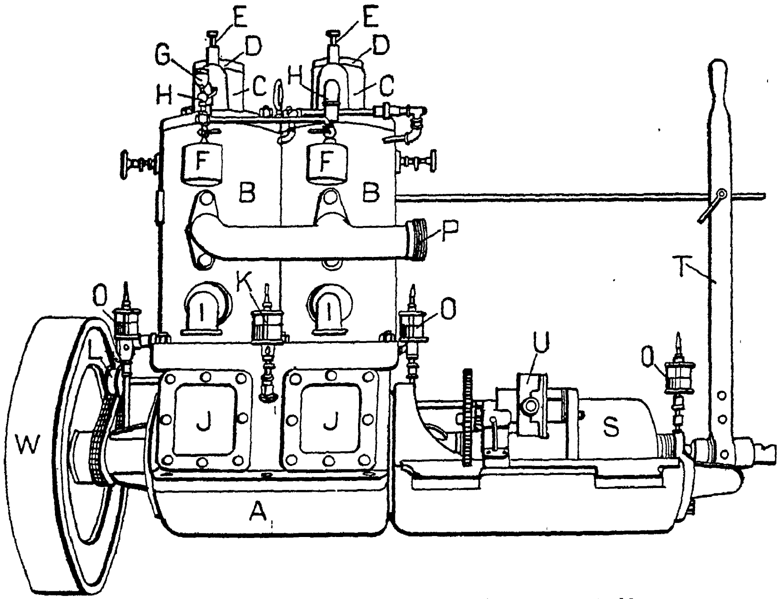

FIG. 130.—MEITZ AND WEISS MARINE ENGINE; Port Side.
(Paragraph 246)

A—Crank Case.
B—Cylinders.
C—Mantles.
D—Dampers.
E—Damper Screw Holders.
F—Burners.
G—Burner Filler.
H—Burner Blow-pipe.
I—Air Inlet.
J—Crank Case Plate.
K—Center Bearing Oiler.
L—Idler.
M—Relief Cocks.
O—Lubricator Oil Wells.
P—Exhaust Fitting.
S—Reversing Gear.
T—Reversing Lever.
U—Circulating Water Pump.
W—Flywheel.

A—Crank Case.
B—Cylinder Proper.
C--Water Jacket.
D—Piston.
E—Connecting Rod.
F—Wrist Pin.
G—Crank Pin.
H—Center Bearing.
I—Air Inlet.
J—Exhaust Fitting.
L—Mantle.
M—Damper.
N—Damper Screw Holder.
O—Igniter Ball.
P—Burner Blow-pipe.
Q—Burner.
R—Burner Filler.
S—Injector Nozzle.
T—Water Feed Pipe.
U—Oil Supply Pump.
V—Oil Pump Handle.
W—Flywheel.
X—Crank Case Plate.
Y—Connecting Rod Box.
Z—Suction Pipe.
1—Sight Feed Lubricator.
2—Center Bearing Lubricator.
3—Center Bearing Lubricator Set Screw.
4—Regulator Handle.
5—Governor.
6—Burner Gauge Cock.

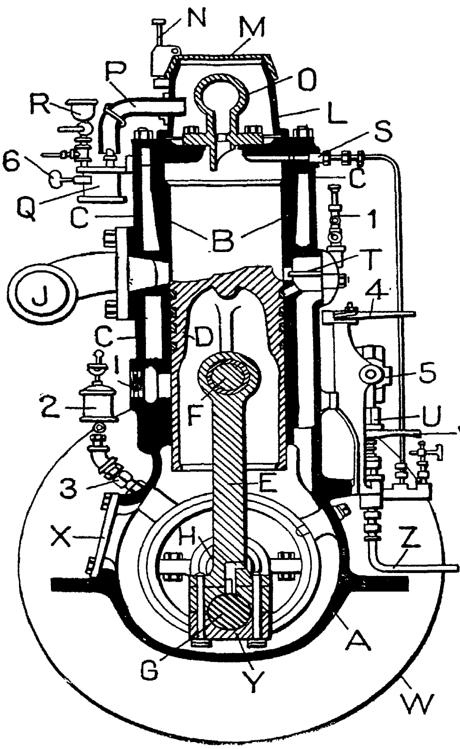

FIG. 131.—MEITZ AND WEISS MARINE ENGINE. Vertical Section through one Cylinder. (Paragraph 246)

from the pump into the cylinder, and the motion of the engine will be reversed.

To stop the motor, push in the throttle so as to throw the oil pump out of action, turn water sight feeds on and off, then close tightly.

247. **Friction Clutch Reversing Gear.** Some efficient type of reversing gear must be fitted to every marine engine so that the vessel may go astern promptly, if necessary. As the operation of an explosion motor is entirely different from that of a steam engine, the former is generally permitted to run continuously in one direction; the reversal being effected by means of the transmission gearing. Some small craft have screws whose blades may be reversed at will, from one hand to the other, thus producing sternward motion with the same direction of rotation. Most boats have solid propellers and are then fitted with a friction clutch gear, a good type of which is shown in *Fig.* 132.

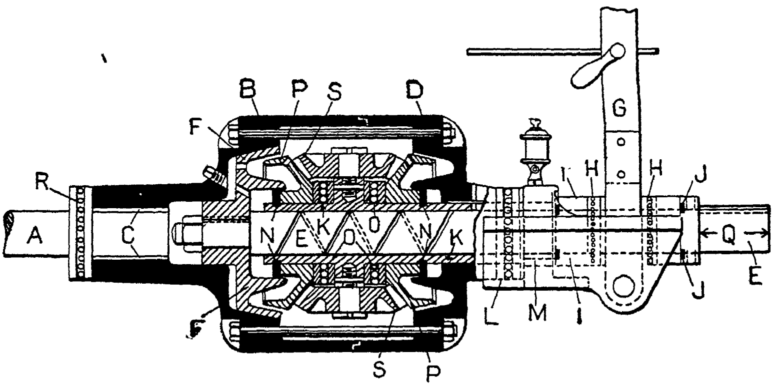

FIG. 132.—FRICTION CLUTCH REVERSING GEAR.
(Paragraph 247)

The crank shaft, A, is keyed to the casing, B, by the keys, C. The casing, B, is rigidly bolted to the casing, D. The stub shaft, E, carries at its inner end the friction cone, F, which engages the inner friction surface of the casing, B. The stub shaft, E, is movable longitudinally by means of the lever, G, and the yoke rings held between the roller bearing thrust collars, I and J; the collars, J, being locked in a circular groove

on the shaft. The bronze sleeve, K, moves longitudinally in the casing and outer bearing, L, the feather, M, in the bearing, L, serving to prevent rotation. The sleeve, K, carries two bevel wheels and two bevel pinions. The two wheels, PP, are held between the collars, NN, and the ball thrust-collars, OO, but are capable of free rotation. The wheels, PP, have coned friction surfaces which engage the friction cone, F, and the inner surface of the casing, D, respectively. The propeller shaft is connected to the projecting part, Q, of the stub shaft, E.

The gear operates as follows: Standing in the *central position,* as shown in the illustration, the engine revolves idly, the propeller shaft remaining stationary. Pushing the lever, G, to the left or *forward,* causes the cone, P, to engage with the inner surface of the cone, F, forcing the latter against the inside of the casing, B. This causes the shaft to run in the same direction as the engine, or *ahead.* Pulling the lever, G, to the right or *aft,* the after cone engages with the casing, D; motion is transmitted through the bevel wheels and pinions, SS, to the inside of the cone, F, causing the latter and consequently the propeller shaft to run in the contrary direction to the engines, putting the boat *astern.*

248. **The Naphtha Engine.** This engine, although operating on naphtha vapor, is essentially an external combustion engine. That is, a portion of the naphtha is burned in a burner and heats another portion contained in a retort until the vapor tension in the latter is sufficient to operate the engine in a manner exactly similar to that of a steam engine. These engines are made in sizes ranging from 1 to 10 horse-power, and are especially suitable for use in small launches.

As shown in *Fig.* 133, the most prominent feature of the installation is the burner and retort, A, mounted on the housing, B, inclosing the engine, the general construction of which and the principal parts thereof are shown by *Figs.* 134 and 135.

The operation of the engine may be best described by brief instructions relative to its management.

Referring to *Fig.* 133, to start the engine, turn air valve, C, from left to right, and give the air pump, D, a few strokes, from two to five strokes being usually sufficient, to force the gas from the tank into the burner, A, where it can be ignited by a match inserted through the hole, E. Heat the retort by means of the flame thus obtained by keeping up the action of the air pump. In warm weather, use the air pump one or two minutes, but in cold weather, the gas generates very slowly and therefore requires a much longer use of the pump.

When the retort is sufficiently heated, open wide the naphtha valve, F, and give from 10 to 25 quick strokes to the naphtha pump, G, which pumps the naphtha from the storage tank in the bow of the boat to the retort. If the retort has been sufficiently heated, the gauge, H, will at once indicate the pressure attained, which ought not to be more than 20 pounds, for starting. Now open the injector valve, J, which supplies fuel to the burner, and keep the damper, K, partially closed, especially if there be much wind blowing. Then, by means of the wheel, L, which is used for both starting and reversing, turn the engine over several times from right to left and from left to right, proper care being taken in the meantime to prevent the fire or flame in the burner from going out, by giving the pump, G, four or five strokes, as often as necessary, to keep the fire burning so as to maintain a pressure of 20 pounds.

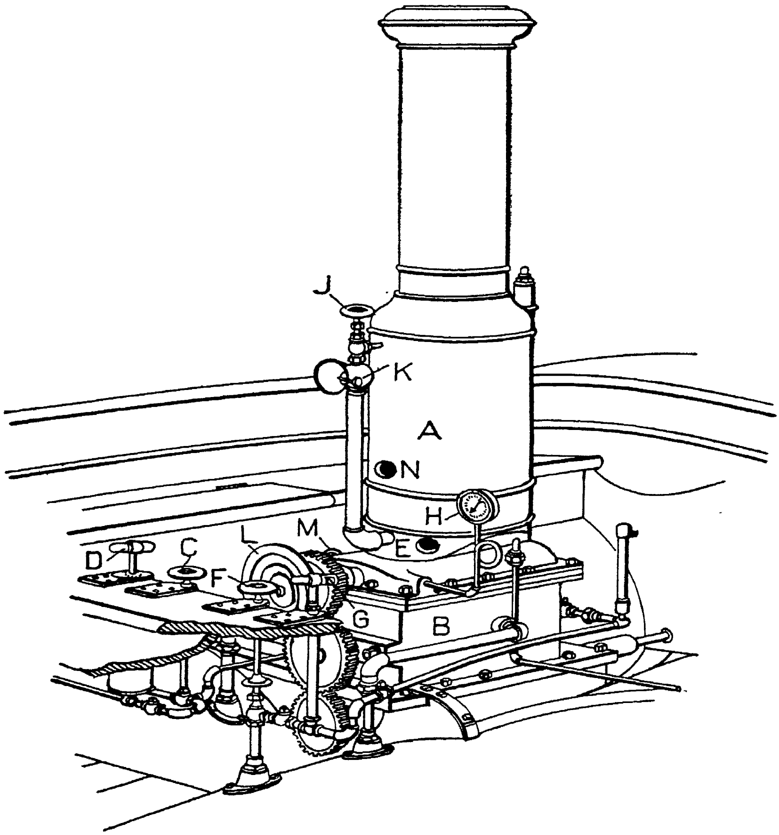

FIG. 133.—NAPHTHA ENGINE INSTALLATION.
(Paragraph 248)

If the fire happens to go out, shut off the injector valve, J, at once; give the air pump, D, a few strokes before relighting; and open the injector immediately afterwards. If the engine turns over hard, block open the safety valve, M, and continue to use the naphtha pump. This operation will allow the pressure to go through the engine and blow out the condensed naphtha collected on top of the piston.

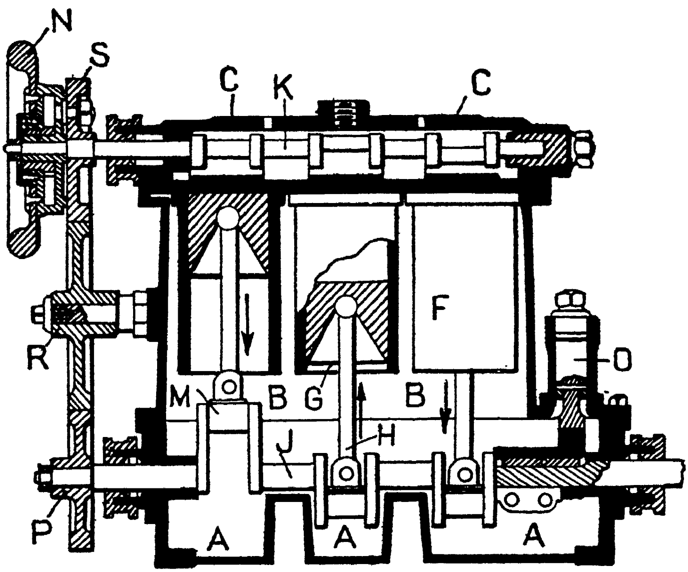

FIG. 134.—NAPHTHA ENGINE.
Longitudinal Section.
(Paragraph 248)

To go ahead, turn the wheel, L, to the left; and to back, turn it to the right.

When once started and brought up to the proper speed, the action of the entire arrangement will be perfectly automatic.

While running, the naphtha valve, F, should be left wide open so as to allow free circulation, and it ought to be examined

occasionally to see that the vibration has not closed it and thus interrupted the supply of naphtha.

If it is necessary to increase the pressure at any time, give a few strokes with the naphtha pump and open wide the injector valve and the damper. While running both the speed and the pressure can be regulated by the injector valve, J, and the damper, K, opening to increase and closing to reduce; and

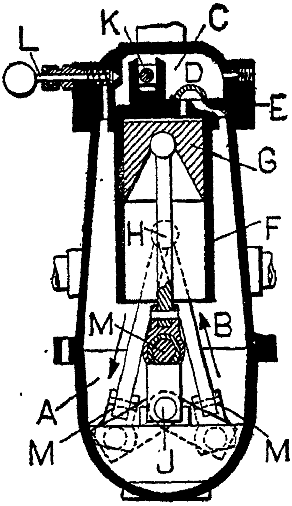

FIG. 135.—NAPHTHA ENGINE.
Vertical Cross Section through one Cylinder.
(Paragraph 248)

by them the engine can be reversed instantly and while going at full speed.

The air pump, D, is used for forcing the gas from the tank to the burner, and also for blowing the whistle. To blow the whistle, turn the air valve, C, from right to left.

When running slowly with the injector valve turned down, the damper, K, should be nearly if not entirely closed.

Perfect combustion of the gas in the burner is indicated by a bluish or almost invisible flame, which may be seen at all times through the hole, N, in the jacket. A red flame means imperfect or poor combustion due to too much naphtha vapor and too little air, and indicates that the injector is too widely opened, and the damper not opened wide enough.

To make a landing, close the injector valve, J, and the naphtha valve, F; stop the engine and fasten the boat.

249. **Alcohol Engines.** There are some twenty-four compound substances known to the chemist as alcohols, of which the two most important are *ethyl*, or ordinary alcohol, and *methyl* alcohol or wood spirit.

The former is generally obtained by the fermentation of sugar under the influence of yeast, which converts a sugary solution into carbon dioxide and a mixture of water and alcohol. The percentage of alcohol contained in this natural solution varies according to its origin, wines having from 7 to 15 per cent., beers from 3 to 5 per cent.

The product of fermentation is distilled to make the solution stronger, the flavor and aroma of the spirit depending upon small impurities, native to the source, which are carried over by the distillate. For pure alcohol, the spirit is re-distilled until *rectified spirits of wine* is obtained, which consists of about 84 per cent. by weight of alcohol, the remainder being water. To obtain *absolute or pure* alcohol, the rectified spirits require to be re-distilled several times, owing to the great affinity alcohol has for water.

Any substance naturally containing sugar, such as grapes, fruits, beet roots, molasses, etc., can be readily fermented into alcohol; other substances require first to be transformed into

sugar before fermentation can take place. Thus farinaceous materials, such as potatoes and various cereals, may easily be converted from starch into sugar, and are consequently available as sources of alcohol.

The conversion may be readily effected by treating the starch with acids, forming commercial *glucose,* which may be readily fermented. A more usual method is to saccharify a starchy solution in warm water by the action of *diastase,* a principle present in malt.

Methyl alcohol is obtained from the dry distillation of wood in closed retorts, giving a watery product known as *pyroligneous acid.* This is repeatedly distilled, in conjunction with various re-agents for the purpose of removing various impurities and the contained water, the crude resultant alcohol being known as wood spirit.

Besides its extended use in connection with fermented beverages, alcohol is of great value in the arts and manufactures as a solvent. It is employed in this manner in the manufacture of varnishes, lacquers, smokeless powder, dyes, in the preparation of ether and other medicines, and in the composition of various chemicals. Containing both carbon and hydrogen, alcohol possesses inherent heating properties, which render it valuable as a liquid fuel, where freedom from dirt, odor or smoke is desired. As it is extremely volatile, it is easily vaporized and is therefore available for use in internal combustion engines.

In most countries a heavy tax is imposed upon ethyl alcohol, for revenue purposes, but in England and most countries of Continental Europe, alcohol has long been subject to little or no duty when utilized for industrial purposes. The sole proviso has been that the alcohol should have been first rendered unfit

for use as a beverage before being placed on sale. This process is known as *denaturing,* and is generally effected by means of the addition of a proportion of *wood-spirit,* which is a poison. To prevent the chemist from re-distilling the ethyl alcohol, a proportion of ½ of 1 per cent. of benzine or other hydrocarbon is added, this also adding a perceptible odor.

In 1906, the Congress of the United States removed the tax on denatured alcohol, in order to grant American manufacturers equal opportunities with those enjoyed by their rivals elsewhere, and it is expected that considerable use will be made of the commercial spirit derived from Indian corn, potatoes, beets, refuse of fruit-preserving establishments, etc.

The proportions given for denaturizing by the Act of Congress are:

100	volumes	Ethyl alcohol	(90%)
10	"	Wood spirit	(90%)
½	"	Benzine	(approved)

In England and Germany the denaturants vary, especially in the latter country, as the use of benzine or wood spirit might prejudice the value of alcohol in the preparation of certain substances. In England the proportion of denaturant is legally $\frac{1}{19}$ of the whole.

Since the development of the internal combustion motor, considerable attention has been paid, more especially in Germany and France, to the possibilities of alcohol as a fuel for this type of engine. The native supply of petroleum is slight in the one country and nothing in the other, so there has been every incentive to evolve a successful fuel derived from home-grown products.

Commercial alcohol is never free from water, and the admixture is always spoken of in terms of the percentage by volume of the pure spirit, thus in the preceding formula for denatured alcohol, ethyl is supposed to contain ten per cent. of water, making ninety per cent. spirit.

The presence of water further reduces the heat contents of the fuel, which is estimated to contain from 11,664 to 12,913 B. T. U. per pound when absolutely pure. For 90 per cent. alcohol, these values are reduced to an amount variously stated as between 10,080 and 11,900 B. T. U. per pound. As one pound of gasoline contains 18,000 to 20,000 B. T. U., the heating power of alcohol is not much in excess of one-half that of the other fuel.

On the other hand, careful experiments have shown that, as a working substance, alcoholic vapor has a greater thermal efficiency than the vapor of gasoline, an efficiency of 28 to 31 per cent. having been obtained. This is probably due to the superior compression, as alcohol is not exploded by the same compression pressure as gasoline but can safely withstand a compression of 150 to 180 pounds per square inch. Just as steam from the water jacket is injected into the cylinders of certain oil engines (par. 236), so the vapor from the admixed water is regarded as adding to the useful effect of the machine.

The benzine, added in the process of denaturizing, is regarded as beneficial to explosion engines, as it neutralizes any acetic acid which may be generated by combustion of alcohol, thus preventing corrosion of piston rings, valves, etc.

Any gas or gasoline engine, whether two or four-cycle, may be operated with alcohol by the use of a suitable carburetter, which is the principal element to be regarded in considering the limitations to the use of alcohol as a fuel. With alcohol, the

carburetter requires to be kept at a much higher temperature than with gasoline, and therefore, it is usual to start the engine and run it with gasoline until it becomes well heated, when the gasoline is shut off and the alcohol turned on. For this purpose, two types of carburetters are employed,—the duplex carburetters of the constant level or float feed type, and the atomizing carburetters.

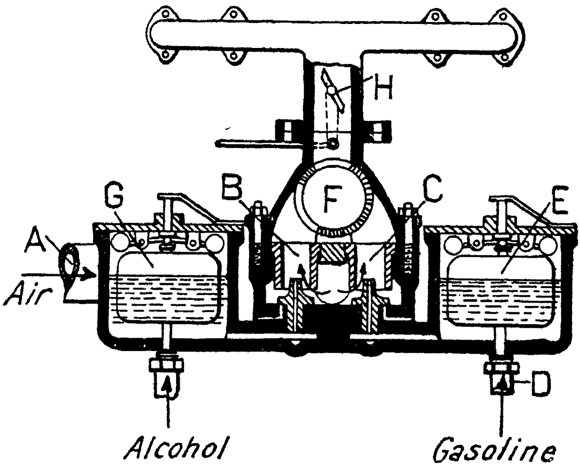

FIG. 136.—MARIENFELDE CARBURETTER.
(Paragraph 249)

Fig. 136, showing a cross section of the Marienfelde carburetter, gives an example of the first type. The air enters through the inlet, A, and surrounds the jets, B and C, in an annular current. The gasoline enters at the inlet, D, and controlled in level by the float, E, passes into the air current through the nozzle at C. The shell valve, F, above the jets is shown in the position required for working the carburetter with alcohol admitted through the float, G, and the jet, B. The engine having been started cold with gasoline, and allowed to

run with that fuel until sufficiently heated, the shell valve, F, is turned to the position shown, thus cutting off the supply of gasoline and turning on the supply of alcohol. The butterfly valve, H, located above the shell valve, operates as a throttle valve to regulate or vary the amount of air and fuel admitted to the cylinder from the carburetter.

Fig. 137, which shows a Martha carburetter, affords an example of the second type. Through the inlet, A, the alcohol enters the spraying chamber, B, and is aspirated by the charging stroke of the engine, together with the air drawn in through the inlet. The alcohol is atomized by contact with the cor-

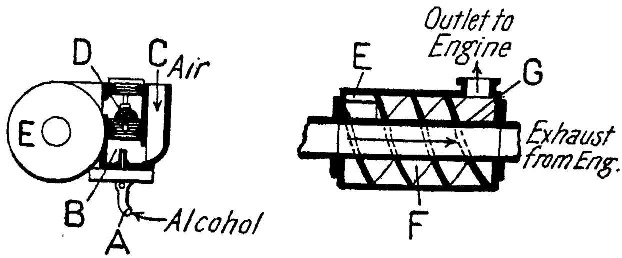

FIG. 137.—MARTHA CARBURETTER.
(Paragraph 249)

rugated surface and the netting of the chamber, D, and passes into the vaporizer, E. The alcohol vapor and air then pass through the spiral channel, F, in contact with the hot exhaust connection, G, and thence out to the engine.

Actual trials, in Germany, of an engine built by Koertings, have shown a consumption of 1.4 pints of 86.2 per cent. alcohol (by weight) per brake horse-power-hour.

Field tests of 120 small engines of three different makes, ranging from 6 to 25 horse-power, in use by farmers and the like, gave the following results,—the trials extending nearly

over a year, the average length of trial being 996 hours. Only one-fifth of the engines used simple denatured alcohol, 81 per cent. using a mixture containing 20 per cent. of gasoline. The consumption varied from 2.35 pints per brake horse-power-hour, as a maximum, down to a minimum of 0.92 pints, the average being 1.22 pints of the mixture per brake horse-power-hour.

For starting purposes, by the tests of 74 engines of 10 horse-power, it was found that 22½ gallons of gasoline apiece would serve for a year.

As nearly as can be seen at present, the useful effect of a given weight of denatured alcohol is about 0.7 that of an equal weight of gasoline, thus necessitating increased cylinder dimensions in the proportion of 1.4 to 1 to obtain equal powers. This increase of cylinder size and necessary modifications to the carburetter are the only structural differences from gasoline motors.

In view of the many advantages of alcohol, the cost factor is the one chiefly to be reckoned with. It is evident that alcohol should not cost more than about four-fifths the price of gasoline in order to be an effective competitor, save for special uses.

With such trials of alcohol-driven motor cars as have taken place, it has been the practice to mix the denatured alcohol with equal weights of gasoline (petrol). With this mixture ordinary gasoline cars have made creditable performances; on alcohol alone, it would have been necessary to use larger cylinders for the same power, as the heat units are so much less in alcohol than in petroleum spirit.

It is well to understand in this connection, that up to the present time on account of the cost of the fuel, the majority of alcohol engines have been of the condensing type. That is, as

in the case of the alco-vapor engines, the alcohol itself is not burned within the cylinder, but is heated externally in a retort by means of a kerosene burner until it is vaporized, and the vapor tension thus produced is employed to drive the piston, in a manner similar to the operation of a naphtha engine.

250. Large Marine Engines. The preceding paragraphs have been exclusively devoted to the consideration of the smaller-sized marine engines, ranging from 1 to 100 horse-power. Successful marine engines of much larger size, ranging from 300 to 500 horse-power are, however, already in successful operation, and marine engines capable of developing 1,000 horse-power are also being built in this country.

The greater number of these engines are of the multi-cylinder double-acting type, operating on the four-cycle principle; and are designed to use either gaseous or liquid fuel, the former being derived from suitable suction gas-producer systems, and the latter from various kinds of fuel oil.

It is important to note that the latest developments in this line are being carefully observed by the naval authorities of various countries, and extensive installations of marine internal-combustion engines are being made by them even at the present time.

In the United States Navy, fourteen vessels, mostly of the submarine type have been equipped with gasoline engines ranging from 10 to 160 horse-power each, and making a total of 1,639 horse-power thus placed in operation. Also four new submarines, one seventy-five foot ferryboat, and two large water barges now under construction, will be equipped with engines ranging from 120 to 250 horse-power each, or a total contem-

plated installation of 1,570 horse-power, giving a grand total of 3,209 horse-power.

Both England and France have made similar installations, and the German navy is building a vessel which is designed to be propelled by a 4,000 horse-power engine.

251. **Advantages of Marine Gas Engines.** The advantages of large marine engines operating on gas, gasoline, or oil, over a steam engine equipment for naval purposes, may be briefly summarized as follows:

1. Equal horse-power with little more than half the weight.
2. An increase in the radius of action from two and a half to three times, by converting the coal into gas.
3. Increased seaworthiness of vessel, especially in the case of torpedo craft, the gain in weight of the machinery being used to greater advantage in the structure of the hull.
4. Ability to attain high speed at night without attracting the attention of the enemy by the glare from the tops of the smoke stacks.
5. Ability to get under weigh quickly without being compelled to maintain a full head of steam at all times.
6. Gain in space by absence of smokestacks, artificial draught arrangements, etc., and freedom from obstructions to the most effective mounting of the armament on the upper decks.

The larger engines usually consist of six cylinders, in which the bore and stroke are equal. *Fig.* 138, is a vertical section through one of the cylinders of a type of double-acting four-cycle engine which is now being constructed by the Standard Engine Company, in sizes ranging from 500 to 1,000 horse-power. The general construction conforms to the best gas engine practice. All the valves are positively operated, water-

cooled, and balanced. The cylinders are amply water-jacketed, and the pistons are cooled by circulating water through the cross head, up a tube in the piston rod, and down a return circuit

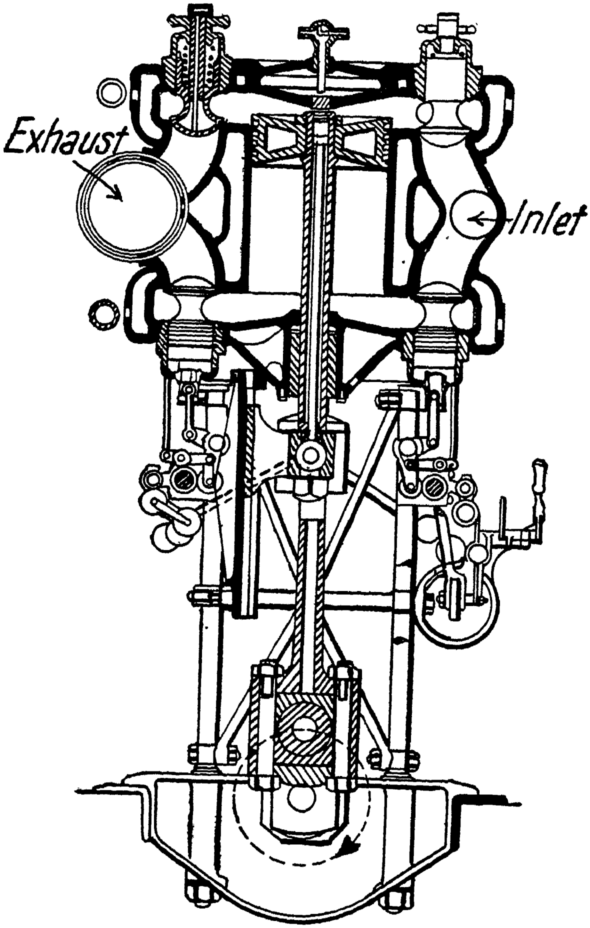

FIG. 138.—DOUBLE-ACTING FOUR-CYCLE GASOLINE ENGINE.
500–1000 Horse-power, Vertical Cross Section.
(Paragraph 250)

around the tube. The engine is started by compressed air at a pressure of 250 pounds per square inch, primarily pumped up into two or more air tanks running along the side of the engine room, by means of small auxiliary gasoline engines which not only drive the air compressor, but also the bilge pumps and a small dynamo for lighting purposes and for charging the storage batteries.

The engine is arranged so as to form two units of three-cylinders each, and the three after cylinders, only, are connected to the compressed air tanks; when the reverse lever is thrown to the first notch off the center, either forward or backward, the cam shaft is shifted to such a position, that the cams operating the compressed air valves on these three cylinders will lift their exhaust valves once every revolution instead of every other revolution. The three forward cylinders always operate on gasoline, the shifting of the cam shaft having the effect of governing the direction of rotation of the engine only. With the lever in this position, the compressed air is admitted to the three after cylinders and the engine allowed to make two or three revolutions. The lever is then pushed on to the next notch, cutting out the compressed air valves and adjusting the cam to trip the valves in the regular four-cycle sequence. Means are also provided by which all the lower exhaust valves can be locked open, and all the lower inlet valves can be locked closed, instantaneously, by a single motion of the lever, thus converting the engine into a single-acting motor developing half power without any material decrease in economy. Furthermore, the two units can be unclutched, so that the three after cylinders can be operated alone as a three-cylinder single-acting unit, thus reducing the power developed to one-quarter the full power of the engine.

An increasingly large number of small pleasure craft are being fitted with gasoline motors for their propulsion; schooners and other trading vessels have also been fitted with auxiliary explosion engines to drive them during calms. The future developments of the marine internal combustion motor may be expected, however, to lie in the direction of the gas engine proper, using gas generated from coal, which may be obtained in any port.

In this case, a gas producer plant would replace the customary installation of boilers, taking up less space, diminishing the labor of stoking, and reducing the weight of machinery. Several vessels have already been built, notably by Thornycroft in England and Lewis Nixon in the United States; the latter builder having navigated gas-propelled torpedo boats across the Atlantic under their own power.

It has been estimated that the weight of a marine gas engine plant would not exceed seven-tenths that of a steam installation of equal power. This feature undoubtedly will be seized upon by naval architects, who will thus be able to devote a greater percentage of displacement to guns and protective armor.

The many auxiliary engines necessary on a warship or mail steamer are responsible for a very large proportion of the fuel consumption of those vessels. If gas-driven, these would be nearly as economical as the main engines. Again, the consumption of the main engines would vary but slightly with changes of speed, a necessary point on warships, which spend most of their time afloat at speeds of ten to thirteen knots, occasionally being called upon to make short bursts at top speed, when all idea of economy is thrown to the winds.

CHAPTER XXII.

TESTING.

252. **Object of Testing.** The ultimate object of testing a gas engine is to determine the economy with which it produces a given amount of power. The factory tests are usually limited to the performance of individual engines,—to determine the set of the governor relative to the proper speed of the engine; to ascertain if the igniter is properly timed, and if the valves open at the proper points in the cycle of operations; and to determine the correct amount of compression.

In the broadest sense of the term, however, testing is a scientific investigation intended to secure practical results highly important not only to the manufacturer, but also to the owner of the engine who has to pay the expense of its operation, and to those who need information respecting the capabilities of the machines.

253. **Determination of Economy.** The economy of steam engines as usually determined, relates to the weight of water consumed, to the quantity of coal used in making the steam, or to the number of heat units supplied; while in other forms of heat engine, it relates to the amount of gas, oil, or other fuel burned.

The heat consumption of internal combustion engines is found by ascertaining the total heat of combustion of the particular fuel used, as determined by a calorimeter test, and multiplying the result by the quantity of fuel consumed. In determining the total heat of combustion no deduction is made for the latent heat of the vapor of water in the products of combustion.

254. Standard Unit of Power. The unit of mechanical power which most satisfactorily expresses the power developed by an engine is the horse-power; therefore, the expressions of engine economy which are best adapted to meet all conditions, and for all classes of heat engines, are those involving the *indicated horse-power* based upon the number of thermal units consumed per hour.

255. Standard Unit of Fuel. A subsidiary form of expressing efficiency is that based on a standard coal unit. The term *standard coal* refers to a coal which imparts to steam 10,000 British Thermal Units for each pound of dry coal consumed. It is a coal which has a calorific value of 12,500 British Thermal Units, equivalent to an efficiency of 80 per cent. (10,000 B. T. U.) when used in a *standard boiler.*

256. Purpose of Test. In making a test, first ascertain its purpose or object,—whether it is made to determine the highest economy obtainable; the working economy and existing defects; or the effect of changes in normal conditions; and arrange the test accordingly.

257. Inspection of Engine. Examine the engine as to its general condition, and note any points of design, construction, or operation, which might have a special bearing on the object of the test.

Examine all the valves and valve seats, the piston and piston rings, and see that they are gas-tight.

See that all bearings and other working parts are in the best possible condition.

258. Measurement of Engine Dimensions. Measure the dimensions of the cylinder when it is hot and in working condi-

tion. Measure the clearance volume. This can be done approximately from the working drawings of the cylinder, but it is better to make it by actual test. For this purpose, set the engine carefully with the piston on its inner dead point. Take a measured quantity of water and pour it into the clearance space, until the whole space, including the ports, is completely filled. Measure the quantity of water left, and the difference will indicate the amount poured in. Measure the water by weight and determine the corresponding volume by calculation, making the proper allowance for its temperature. The clearance volume or ratio of clearance is the volume in cubic inches thus found divided by the volume of the piston displacement in cubic inches, the result being expressed as a decimal.

259. Calibration of Instruments. Calibrate all instruments and apparatus to be used in the test, and determine their accuracy and reliability by comparing them with recognized standards. Thermometers, pressure gauges, and indicator springs should be calibrated both before and after the tests. See Chapter XXIII.

260. Duration of Test. The length of time given to a test largely depends upon its character and the purpose for which it is made. For determining working economy, the duration of the test should cover a period equal to the number of hours per day during which the engine is usually operated.

In the case of an engine using producer gas, the length of time devoted to the test should be long enough to determine the amount of coal used in the gas producer. It should never be less than twenty-four hours, and preferably should extend over several days.

261. **Commencement of Test.** If the test is made to determine the performance of the engine under working conditions, it should begin at the time the engine is started on its regular work, and the observations continued until it shuts down for the day.

If the test is for determining the maximum economy of the engine, it should first be run a sufficient length of time so as to make all conditions normal and constant. Then begin the observations and continue them during the allotted period.

262. **Measurement of Fuel.** The methods of determining the fuel consumption depend upon the character of the fuel used.

If it be coal furnished to a gas producer, its name, size, per cent. of moisture, and quality should be ascertained, and the quantity supplied to the gas producer during a stated period, not less than twenty-four hours, should be carefully measured.

If it be oil, gasoline, alcohol, or distillate, it can be drawn from a tank, which may be refilled to the original level at the end of the test, and the amount, required for refilling, weighed, allowances being made for alterations in temperature; or in the case of a small engine, it can be drawn from a properly calibrated vertical pipe.

When gas is used, it should be measured by a suitable gas meter, and gas bags should be placed between the meter and the engine to keep the pressure as constant as possible.

The pressure and temperature of the gas, and the barometric pressure and temperature of the air, should be measured, and in determining the quantity of gas supplied as given by the reading of the meter, the temperature and pressure of the gas should be taken into account, as given in pars. 282, 283.

263. **Number of Heat Units Used.** The number of heat units used by the engine is found on multiplying the number

of pounds of coal or oil, or the cubic feet of gas supplied, by the total heat of combustion of the fuel as determined by a calorimeter, or from the data obtained by a chemical analysis. See paragraph 285.

264. **Measurement of Jacket Water.** The jacket-water can be measured by a water meter, or by a measuring tank, either before it enters the jacket, or after its discharge therefrom, as specified in paragraphs 287 and 292.

265. **Determination of Speed.** The speed of the engine or the number of revolutions of the crank shaft per minute, can be determined by counting the number of revolutions in two minutes, with the eye fixed on the second hand of a time piece; or by the use of some form of mechanical counter such as a tachometer or continuous recording engine register as described in paragraph 290.

In the case of an engine governed by the hit-or-miss method, the number of explosions per minute should be ascertained, when the engine is running under nearly maximum load, by counting the number of times the governor causes a miss in the number of explosions.

266. **Indicator Diagrams.** From the indicator diagrams taken during the test for the calculation of the mean effective pressure, etc., sample diagrams nearest to the mean should be appended to the report so as to give a complete record of the test.

267. **Standards of Economy and Efficiency.** The standard expression for engine economy is the indicated horse-power, or the brake horse-power, divided by the hourly consumpton of heat units.

The standard expression for efficiency is the thermal efficiency ratio or the proportion which the heat equivalent of the power developed bears to the total amount of heat actually consumed as determined by test. In this case, one horse-power per hour represents 1,980,000 foot-pounds of energy, and this divided by 778 foot pounds,—the mechanical equivalent of one British Thermal Unit, gives 2,545 for the numerator of the expression—

$$\frac{2{,}545}{\text{B. T. U. per H. P. per hour,}}$$

which expresses the thermal efficiency ratio.

268. **Computations and Results.** From the data obtained according to the rules prescribed in the foregoing paragraphs, there should be computed the following results:—

269. **The Indicated Horse-Power.—I. H. P.** This is expressed by the formula—

$$\text{I. H. P.} = \frac{\mathbf{E} \times \mathbf{P} \times \mathbf{A} \times \mathbf{L}}{33{,}000}$$

in which **E** is the number of explosions per minute; **P** the mean effective pressure in pounds per square inch; **A** the area of the piston in square inches; and **L** the length of the piston stroke in feet, and in which—

$$\frac{\mathbf{A} \times \mathbf{L}}{33{,}000}$$

is constant for a given engine. The constant 33,000 represents the number of pounds raised through one foot in one minute by one horse-power.

270. **The Mean Effective Pressure.—M. E. P.** The mean effective pressure is that obtained from the indicator diagram as follows:

Measure the area of the diagram with a planimeter, and divide the area in square inches by the length of the diagram to obtain the mean ordinate or the mean height of the diagram. Multiply the mean ordinate by the scale of the indicator spring and the product will be the mean effective pressure desired.

The more usual method is to measure off ten equidistant ordinates on the diagram, and multiply their average by the scale of the spring, the product being the mean effective pressure.

If the indicator is especially designed with a reduced piston for indicating gas engine pressures, the mean ordinate should be multiplied by twice the scale of the spring, unless the scale has been expressly marked for the reduced piston. See paragraph 288.

When indicator diagrams are not available, and the compression pressure is known, the mean effective pressure can be determined approximately under the following conditions:

In gas engines the compression pressures range from about 70 to 90 pounds per square inch, and the maximum pressures are about 3.5 times the compression pressures.

Therefore, if P_c represents the compression pressure, then for compression pressures up to 100 pounds per square inch, the—

$$\text{M. E. P.} = 2P_c - 0.01P_c^2;$$

so that, if $P_c = 70$ pounds per square inch, then

$$\text{M. E. P.} = 140 - 49 = 91 \text{ pounds per square inch.}$$

271. The Brake Horse-Power.—B. H. P. When this is determined by some form of dynamometer such as the Prony brake, it can be computed by the formula—

$$\text{B. H. P.} = \frac{W \times N \times L \times C}{33{,}000}$$

in which W is the net weight in pounds on the scales; N the

number of revolutions per minute; **L** the length of the lever arm from the center of the braked wheel to the knife edge of the brake, or the radius of the brake wheel in the case of a rope brake (continental engineers measure to the centre of the rope on either side); and **C** the circumference of the braked wheel.

As—

$$\frac{L \times C}{33{,}000}$$

is constant for a given Prony brake, if **L** be made 5.25 feet this constant becomes 0.001, and gives the simple formula—

$$\text{B. H. P.} = \frac{N \times W}{1{,}000}$$

272. **Indicated Horse-Power or Brake Horse-Power converted into Heat.** The number of foot-pounds of work done by one pound or one cubic foot of fuel divided by 778, the mechanical equivalent of one British Thermal Unit, will give the number of heat units desired.

273. **Heat carried away by the Jacket Water.** This is determined by measuring the amount of cooling water passed through the jacket equivalent to one pound or one cubic foot of fuel consumed, and calculating the amount of heat rejected, by multiplying that amount by the difference in the temperature of the water entering and leaving the jacket.

274. **Heat rejected in the exhaust gases.**—The sum of the heat converted into brake horse-power and the heat carried away by the jacket water, subtracted from the total heat supplied will give the total heat rejected or unused.

In order to determine the cost of each horse-power hour in

thermal units, the temperature and pressure of the gas consumed and the air supplied, should be reduced to standard conditions.

The most suitable standard for gas engine work is the equivalent volume of gas at normal atmospheric pressure (29.92 inches of mercury) at a temperature of 60° Fahr.

The gas consumed may be reduced to this standard by multiplying the reading of the volume by the factor given at the end of paragraph 286, or more conveniently by means of the following formula—

$$v = \frac{t}{p} \times \frac{v'p'}{t'}$$

in which v = volume of gas reduced to standard; $t = 461° + 60° = 521°$ Fahr., absolute standard temperature; $p = 29.92$ inches of mercury; v' = volume of gas registered by meter; p' = pressure of gas at meter measured by manometer in inches of mercury; and t' = absolute temperature of the gas.

Since t and p are constants—

$$v = 18.00 \frac{v' p'}{t'}$$

and as p' and t' are nearly constant during any given test—

$$v = E v'$$

in which—

$$E = 18.00 \frac{p'}{t'}$$

and p'=height of barometer + (0.073 × reading of water-manometer); and t'=temperature of gas at meter + 461°.

For example: Assuming the height of the barometer as 29.40; the reading of the manometer as 6 inches; the temperature of the gas as 80° Fahr.; and the volume of the gas reg-

istered at the meter as 350 cubic feet, we have for determining v—the equivalent volume of gas for standard conditions——

$$p' = 29.40 + (0.073 \times 6) = 29.84,$$
$$t' = 80^\circ + 461^\circ = 541^\circ,$$

and
$$E = \frac{18.00 \times 29.84}{541} = 0.993$$

Then $v = 0.993 \times 350 = 347.5$ cubic feet.

275. **The Air Supplied** should be metered and reduced to standard conditions in a similar manner.

If the rate method is employed to ascertain the amount of gas consumed, the number of cubic feet for a ten-minute interval may be found by dividing the number of cubic feet, registered by one revolution of the small dial, by the time in seconds elapsed at the completion of that revolution, and multiplying the result by 6,000.

276. **Total B. T. U. per Hour.** The total amount of gas consumed in cubic feet, multiplied by its calorific value.

277. **B. T. U. per Brake Horse-power-Hour.** The total B. T. U. per hour divided by the brake horse-power.

278. **B. T. U. per Indicated Horse-power-Hour.** The total B. T. U. per hour divided by the indicated horse-power.

279. **Friction Horse-power.** The difference between the indicated horse-power and the brake horse-power.

280. **Thermal Efficiency.** The ratio of 2,545 B. T. U. to the B. T. U. per horse-power-hour.

281. **Mechanical Efficiency.** The ratio of the brake horse-power to the indicated horse-power.

CHAPTER XXIII.

INSTRUMENTS USED IN TESTING.

282. Pressure Gauges. Gauges for measuring the pressure of steam or other gases are made in a great variety of forms. Generally, the pressure of the gas causes a pointer to move around a graduated dial under the influence of the motion of a corrugated diaphragm, or as in the Bourdon gauge, in response to the tendency of a bent tube to straighten itself under the influence of pressure.

For pressures above that of the atmosphere, one of the most convenient and reliable instruments of this kind is the dead-weight testing apparatus. This consists of a vertical plunger working in a cylinder containing oil or glycerine, which transmits the pressure to the gauge. The plunger is surmounted by a circular stand on which weights may be placed so as to obtain any desired amount of pressure. The total weight, in pounds, on the plunger at any time, divided by the average area of the plunger and of the bushing which receives it, in square inches, gives the pressure in pounds per square inch.

Another reliable standard of comparison is the mercury gauge. This consists of a U-shaped glass tube about 30 inches long, with both arms filled with mercury. A stop-cock is usually placed between the gauge and the cylinder of the engine. When the stop-cock is open the pressure of the gas on the mercury in one arm of the tube forces it down so that it rises in the other arm. The difference in the heights of the two columns corresponds to the excess of pressure of the gas over that of the atmosphere. In using this instrument, great care should be

taken to see that it is correctly graduated with reference to the ever-varying zero point, the exact position of which depends upon the density of the mercury and volume of the tube as affected by the temperature. The mercury should be pure, and the proper correction should be made for any difference of temperature that may exist at the time of using, as compared with the temperature at which the instrument was graduated.

For pressures below the atmosphere, an air pump or some other means of producing a vacuum should be employed. It should always be compared, however, with a mercury gauge before using.

283. **Thermometers.** Standard thermometers are those which read 212° Fahr., when the whole of the stem up to that point is surrounded by steam escaping from boiling water at the normal barometric pressure of 29.92 inches of mercury; which read 32° Fahr., when the stem is completely immersed to that point in melting ice, and which have been tested and certified, between and beyond these two points of reference, by the proper authorities.

For temperatures between 212° and 400° Fahr., comparisons should be made with the temperatures given in Regnault's Steam Tables, by placing the thermometer in a well of mercury surrounded by saturated steam under sufficient pressure to give the desired temperature. The pressure should be accurately determined by some one of the methods already described with reference to gauges.

284. **Pyrometers.** These instruments are generally used for measuring temperatures higher than 648° Fahr.,—the boiling

point of mercury. They are made in a great variety of forms, usually based on the general tendency of metals to expand under the influence of an increase in temperature.

Perhaps the most useful instrument of this kind is that devised by Le Chatelier. It consists of two pieces of wire of but slightly different composition, which are enclosed in a long tube of porcelain or fire clay. These wires are platinum and an alloy of 90 per cent. platinum and 10 per cent. rhodium. The action of heat sets up electricity in the wires, forming a thermo-couple, and the electric current produced by an increase in temperature is measured by a galvanometer. It measures, readily and accurately, temperatures as high as 3,000° Fahr.

When a pyrometer is used, it should be compared with a mercurial thermometer within its range, and if greater accuracy is desired at very high temperatures, it should be compared with an air thermometer, which is the accepted ultimate standard of reference in all high temperature measurements.

285. Calorimeters. These consist of various forms of apparatus used for the purpose of ascertaining the calorific values of substances used for fuel. The rational method of determining the total heat of combustion of a substance is to burn it in an atmosphere of pure oxygen gas.

For this purpose, the Barrus and Mahler calorimeters are among the most reliable for solid fuel or oil, and the Junker calorimeter for gases.

The Barrus calorimeter is especially applicable to the testing of coal. As shown by *Fig.* 139, it consists of a glass beaker, A, 5 inches in diameter and 11 inches high. The combustion chamber is of special form, consisting of a glass bell, B, having a notched rib around the lower edge and a bead just above the

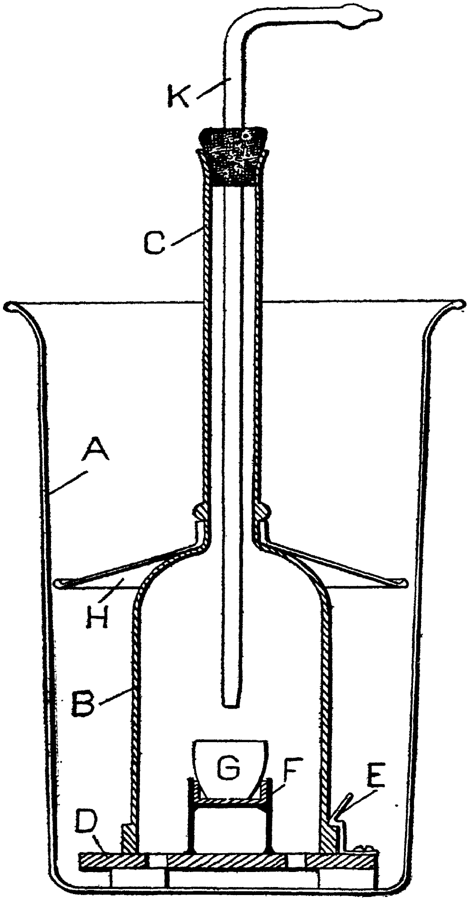

FIG. 189.—BARRUS COAL CALORIMETER.
(Paragraph 285)

dome, with a tube, C, projecting a considerable distance above the upper end. The bell is 2½ inches inside diameter, 5½ inches high, and the tube, C, ⅝ inches inside diameter, extending to a height of 9 inches beyond the bell. The base, D, consists of a circular piece of brass, 4 inches in diameter, and is provided with three clips, E, fastened on the upper side for the purpose of holding down the combustion chamber. A cup, F, for holding the platinum crucible, G, in which the coal is burned, is attached to the center of the plate. A hood, H, made of wire gauze is attached to the upper end of the bell beneath the bead, for the purpose of intercepting the rising bubbles of gas and thus retarding their escape from the water. The top of the tube, C, is fitted with a cork through which a small glass tube, K, carries the oxygen to the lower part of the combustion chamber.

The tube, K, is movable up and down, so as to permit of its being adjusted to the proper distance from the burning coal, and also to some extent sideways, so that the current of oxygen may be directed to any part of the crucible.

To make a test with this instrument, the following named apparatus is required: A tank of oxygen, scales for weighing water, delicate balances for weighing coal, an accurate thermometer graduated to tenths of a degree Fahr., for taking the temperature of the water, and a thermometer to give the temperature of the atmosphere.

Fig. 140, shows the general arrangement of Junker's calorimeter. The apparatus is designed for determining the number of heat units in a given volume of gas, such as a cubic foot or a cubic meter. It consists of a meter, A, a pressure regulator, B, and a calorimeter proper, C. The gas enters the meter at *e*, and passes through the pressure regulator to the calorimeter proper, where it burns at the burner, *f*. The products of com-

bustion rise to the top of the calorimeter and enter a double row of pipes which are surrounded by circulating water, and after passing down through the pipes they issue at the flue, *g*.

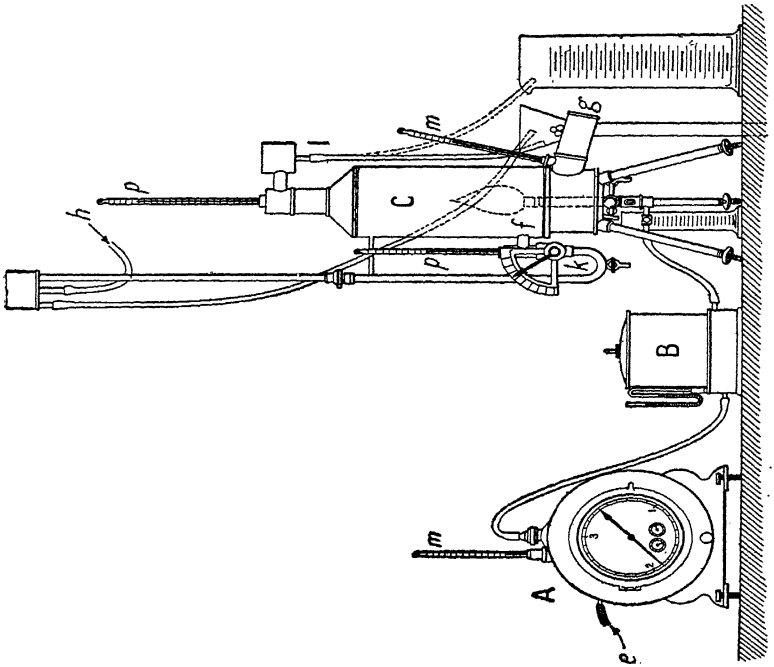

FIG. 140.—JUNKER'S CALORIMETER.
(Paragraph 285)

The water enters at *h*, and passing through the regulating cock, *k*, enters the calorimeter; circulates around the tubes, and issuing at *l*, flows into the measuring glass. The thermome-

ters, *mm* and *pp,* register the temperature of the gas and water respectively, upon entering and leaving the apparatus.

The heating value of the gas is computed by the formula:

$$H = \frac{(t - t') w}{v}$$

in which t is the average temperature of the entering water; t' the average temperature of the issuing water; w the weight of the cooling water in pounds; and v the number of cubic feet of gas reduced to standard conditions of temperature and pressure.

This value will be too large, however, as the water formed by the combustion of hydrocarbons in a gas is not condensed, and therefore passes off with its latent heat of vaporization into the exhaust.

The effective heat value of the gas will, therefore, be found by multiplying the weight of condensed water in pounds by 966, and dividing the product by the number of cubic feet of gas, and subtracting the result from the computed value of **H.**

286. **Gas Meters.** These instruments are used for measuring the gas supplied to engines or calorimeters. They are of two kinds,—*wet meters* and *dry meters.* The former, on account of the various difficulties connected with their use, the chief of which is the liability to freezing in cold weather, have been almost entirely superseded by the latter.

The dry meter consists of a rectangular box of tin-plate, divided into two main compartments by a horizontal partition. The lower compartment is still further subdivided into two equal parts by a vertical partition. The measuring device consists of two bellows, one in each division of the lower com-

partment. Each set of bellows consists of a circular metal disc to the circumference of which is fastened one edge of a leather diaphragm, the other edge of which is fastened to the central partition. The whole arrangement forms a gas-tight space. The pressure of the gas as it is admitted, first into the space inside, and then into the spaces outside of the bellows, opens and closes them alternately, thus furnishing the motion which operates the inlet and outlet valves in such a way that gas cannot pass simultaneously into and out of any one of the spaces. This motion also works the train of gearing which records the amount of gas passed through the meter, and the action of the mechanism also controls the extent to which a bellows can open and close, so that a definite volume of gas passes into and out of the meter each time it is filled and emptied.

When a meter is used in a gas engine test, it should be calibrated by comparing its readings with the displacement of a gasometer of known volume; by comparing it with a meter of known error; or by passing air through the meter from a tank containing air under pressure. In the latter case, the temperature and pressure of the air from the tank should be observed, both at the tank and the meter, at regular or equal intervals of time during the progress of the comparison.

The volume of air passing through the meter is computed from the volume of the tank and the observed temperatures and pressures, and the volume thus ascertained should be reduced to its equivalent at a given temperature and pressure, and corrected for the effect of moisture in the gas, which is, as a rule, at or near the point of saturation.

The most suitable standard for gas engine work is the equivalent volume of the gas when saturated with moisture at the normal pressure of the atmosphere at a temperature of 60° Fahr.

The reading of the volume containing moist gas at any other temperature may be reduced to this standard by multiplying it by the factor,—

$$\frac{459.4 + 60}{459.4 + t} \times \frac{b - (29.92 - S)}{29.4}$$

in which **b**, is the reading of the barometer in inches at 32° Fahr.; **t**, the temperature of the gas at the meter in degrees Fahr., and **S**, the vacuum in inches of mercury corresponding to the temperature **t**, obtained from the steam tables.

287. Water Meters. These devices are used for measuring and automatically recording the quantity of water flowing through pipes. They are of three classes,—the *positive meter* which measures the actual volume of water passing through the pipe with which it is connected; the *inferential meter* which measures some element or factor of the flow, usually the velocity; and the *proportional meter* which measures a fractional part of the flow, thus enabling the use of a relatively small meter which can be attached to a by-pass on the main pipe. In all of them, the registering mechanisms consist of an arrangement of cogwheels by which the movement of the water is transmitted to a series of graduated dials.

When used for testing purposes, they should be carefully calibrated by some reliable method.

288. Indicators. Gas engine indicators practically operate on the same principle as those used on steam engines, but are

made much stronger so as to indicate the higher pressures successfully. They are equipped with a smaller piston and a stronger spring, and the pencil arm is made much stouter so as to withstand the sudden shock developed in a gas engine cylinder at the moment of explosion.

When used in a test, the indicator springs should be calibrated by compressed air, or compressed carbonic acid gas, great care being taken to maintain temperature conditions similar to those which exist during a test. If it is desired that the springs should be calibrated under constant pressure, the whole range of pressures through which the indicator acts should be covered as follows: first, gradually increase the pressure from the lowest to the highest point, and then gradually reduce it from the highest to the lowest point and take the mean of the results. The calibration should be made for at least five points,—two for the pressures corresponding to the maximum and minimum pressures, and three for pressures at intermediate, equally distant points.

The most reliable standards of comparison are the dead-weight testing apparatus and the mercury column. A steam gauge, the accuracy of which has been previously determined by comparison with either of these standards, may also be satisfactorily used.

Fig. 141, shows a part sectional view of the American-Thompson indicator with the new detent motion.

In working out the mean effective pressure from the indicator diagrams, the correct scale of the spring will be the average based on its calibration, and it can be ascertained in the following manner:

When the scale of the spring varies from the nominal scale uniformly, the arithmetical mean of the scales obtained at the

different pressures tried, will be sufficiently accurate. On the other hand, when the scale varies considerably at the different

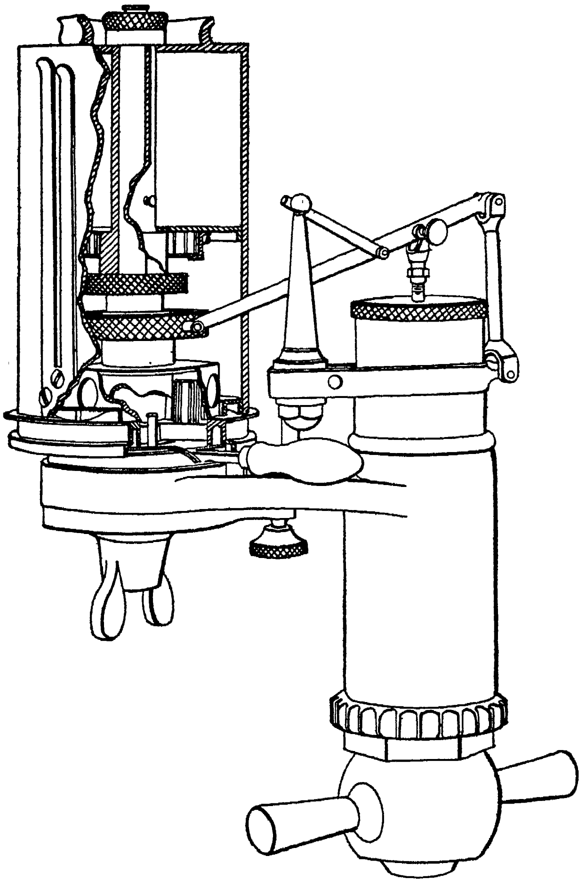

FIG. 141.—AMERICAN THOMPSON INDICATOR.
(Paragraph 288)

points, absolute accuracy can be attained by the following method: select a sample diagram and divide it into a number of

parts by drawing lines parallel to the atmospheric line. The number of lines should equal and correspond to the number of points at which the calibration is made. Take the mean scale of the spring for each division and multiply it by the area of the diagram lying between two contiguous lines. Add all the products together and divide by the area of the whole diagram, the result will be the average scale required.

289. **Planimeters.** These instruments are used for automatically measuring the areas of irregular figures on a plane surface. They are made in a number of forms, usually consisting of two arms hinged at one end, the outer end of one being a pointed support, and that of the other a pencil. A graduated roller is attached to the pencil arm, with its axis parallel to that of the arm. To obtain the area of an indicator diagram, the pointed support is fixed at some point outside of the diagram, and the instrument is moved bodily about it with the pencil or tracer following the bounding line of the figure. When the circuit is completed by the pencil, the area of the figure will be indicated by the reading of the roller.

290. **Revolution Counters and Tachometers.** These devices are used for determining the speed of an engine, by automatically counting and recording the number of revolutions of the crank shaft. Their use is absolutely necessary when the speed of an engine exceeds 250 revolutions per minute. In a test, the use of a continuously recording counter is necessary to give the most reliable results.

291. **Brakes and Dynamometers.** These consist of various forms of apparatus used for determining the brake horse-power of an engine.

The most familiar form is the Prony brake, consisting of a friction band which may be placed around the fly wheel or around the crank shaft, and attached to a lever bearing upon the platform of a weighing scale, as shown in *Fig.* 142. A brake used for testing purposes should be self-adjusting to a certain extent, so as to maintain, automatically, a constant resistance at the rim of the wheel. For comparatively small engines, various forms of rope brakes, such as the one shown in *Fig.* 143,

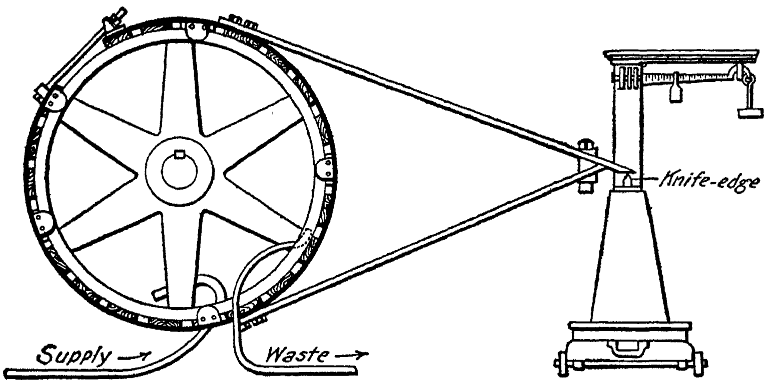

FIG. 142.—PRONY BRAKE.
(Paragraph 291)

satisfy this requirement very well. In such cases, a specific weight is hung to one end of the rope and a spring scale to the other end. The wheel should be provided with interior flanges, holding water for keeping the rim cool. For very high speeds, some form of water-friction brake should be employed, as they have the advantage of being self-cooling. They have been successfully used at speeds of over 20,000 revolutions per minute.

292. Tanks. In some cases, tanks may be used more conveniently than meters for measuring the jacket-water. A simple

apparatus of this kind consists of a small hogshead with a capacity of about 6,000 pounds of water per hour, connected to the suction pipe, and an ordinary oil barrel, the latter being mounted on a platform-scale supported on one side by the hogshead and on the other side by a suitable staging. The barrel is filled by means of a cold-water pipe leading from the source of

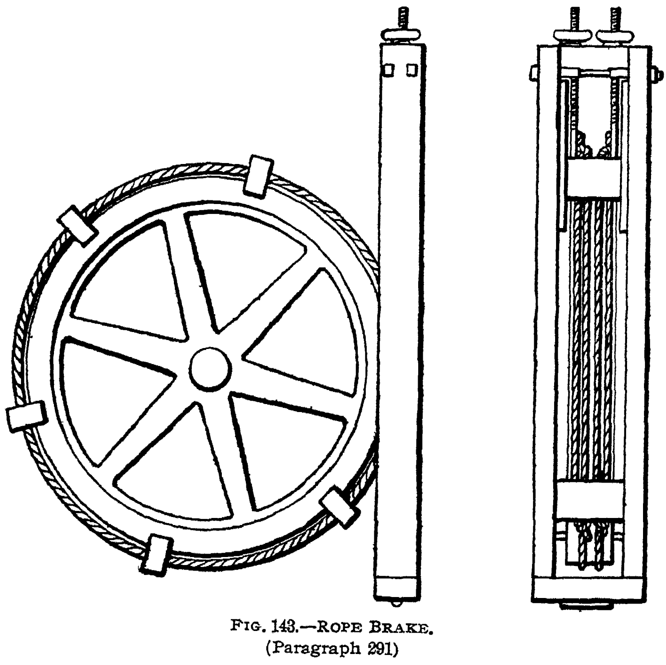

FIG. 143.—ROPE BRAKE.
(Paragraph 291)

supply. For pressures not less than 25 pounds to the square inch, this should be a 1½ inch pipe. The outlet valve should be attached to the side and close to the bottom of the barrel, and should be at least 2½ inches in diameter so as to allow quick emptying. Where large quantities of water are required, the barrel can be replaced by a hogshead, and two additional hogs-

heads can be joined together for the lower reservoir. When the weighing hogshead is thus supplied through a 2½ inch valve under a pressure of 25 pounds and emptied through a 5-inch valve, the capacity reached is 15,000 pounds of water per hour. For still larger capacities, rectangular tanks may be used with the weighing tank so arranged that the ends overhang the scales and the reservoir below, and the outlet valve, consisting of a flap-valve, covers an opening in the bottom 6 or 8 inches square. The rectangular tank system can be employed for any size of stationary engine met with in ordinary practice.

When very large quantities of water have to be measured, or in some cases, relatively small quantities, the orifice method is the one that can be used most satisfactorily. In such cases, the average head of water on the orifice must be determined, and it is also important that proper means should be taken for calibrating the discharge of the orifice under the conditions of actual use.

In measuring jacket-water, or any supply under pressure, which has a temperature over 212° Fahr., the water should be first cooled, as may be done by discharging it into a tank of cold water previously weighed, or by passing it through a coil of piping submerged in colder running water, thus preventing the loss by evaporation which attends the discharge of hot water into the open air.

CHAPTER XXIV.

NATURE AND USE OF LUBRICANTS.

293. **Lubricants for Various Purposes.** One of the most important considerations in connection with the operation of an engine, of any power, relates to the proper lubrication of its moving parts. As is perfectly evident on reflection, it is necessary that all such parts should be supplied with oil or lubricating grease, but it is also a fact, not so well understood, that different kinds of lubricant are necessary for different kinds of mechanisms.

294. **Lubricants for Gas Engine Cylinders.** The piston is the most important part of an engine. Upon it is expended the force generated by the explosion, and, upon its tightness or freedom from leakage, depends the development of power and the maintenance of proper compression, so necessary for economical running.

The piston usually travels at great velocity, and is subject to high temperatures, which militate against efficient lubrication. As it moves to and fro it presses against the cylinder walls, exposing them to the burning gases, thus rendering the coating of oil, which is used to lessen friction, liable to be volatilized or carbonized.

The oils for internal lubrication must be carefully chosen, as the temperatures within the cylinder of a gas engine are far higher than those experienced with a steam engine cylinder. Regard must be paid to their quality, a perfectly pure mineral oil being necessary, entirely free from admixture with animal or vegetable matter, and possessing a flash point as high as pos-

sible. The specific gravity of such an oil, when of the highest quality, will lie between .885 and .890 at 62° Fahr.; it will begin to evaporate at about 360° Fahr., and have a flash point of well over 500°, probably 520°, while its burning point lies between 625° and 645° Fahr. This oil thickens rapidly in cool weather, solidifying at about 40° Fahr. It has a viscosity of between 11.5 and 12.5, as compared with water, at a temperature of 140° Fahr.

It is perfectly practicable to use an oil, having the flash point mentioned, in a gas engine cylinder, whose temperature at explosion is very much higher, because, with a properly adjusted water circulation, the burning and carbonization of the oil is constantly prevented. The heat-absorbing action of the jacket-water is also efficient in retaining at the required point the viscosity of the oil—that is to say, the quality of dripping at a certain ascertained rate through a narrow aperture under pressure. This quality virtually refers to the thinness of the oil.

It is also necessary to have an oil with a low freezing point, as a very necessary insurance against congealing, and consequent delay and inconvenience in starting the engine. Its resistance to heat should also be placed at such a figure that it will not become unusually thin, as will some qualities of oil, its viscosity being maintained at the desired point.

A method of forced cylinder lubrication is illustrated in *Fig.* 144, showing how the oil is supplied to the piston and cylinder walls, at another part of the stroke to the piston pin, and at another time to the crank pin bearing, all through the same supply.

295. **Organic Oils.** For lubricating machinery as apart from cylinders, it is customary to use organic oils of animal or vegetable origin, on account of the greater *body* or viscosity

which they possess, as compared with mineral oils. To make these oils cheaper, they are admixed with a large proportion of mineral lubricant. While such oils serve admirably for those parts of a gas engine which correspond to the running gear of a steam engine, they are entirely inadmissible about a fast running gasoline motor, where the running parts are enclosed in a heated crank-case.

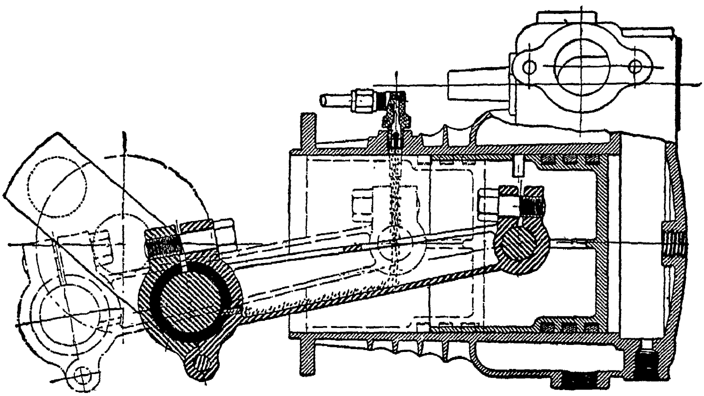

FIG. 144.—HORIZONTAL CYLINDER OILED BY FORCE-FEED OIL DISTRIBUTER. The piston is oiled when passing under oil port, as shown by the dotted outline. The connecting rod is longitudinally grooved on the upper surface, so as to carry oil to the bearings. (Paragraph 294.)

Vegetable oils readily carbonize at high temperatures, forming a thick rusty colored deposit, which often sets hard, choking up ports and passages, creating much friction, and damaging the piston and its rings. A lubricant of animal origin, while not so liable to form carbon deposits, is apt to decompose into fatty acids, corroding the working parts.

With a good cylinder oil, the slight deposit left is usually of a blue grey or slaty color, and is harmless.

296. Use of Graphite as a Lubricant. Many authorities strongly recommend the use of powdered or flaked graphite, in the cylinders of explosive engines, for the reason that this substance is one of the most efficient of solid lubricants, especially at high temperatures. It has been found especially useful in some steam engine cylinders, and in general on those bearings and moving parts liable to become overheated. According to several well-known authorities, it is well adapted for use under both light and heavy pressures when mixed with certain oils. It is also especially valuable in preventing abrasion and cutting under heavy loads at low velocities.

In using graphite as a lubricant, it is positively essential to remember one thing: It is, as said, very useful for certain purposes, when mixed with some liquid oil lubricants. However, it is impossible to use it in connection with oils that are to be filtered through the small orifices of constant feed oil cups, as on the cylinders and bearings of engines. The reason for this is that it will not flow through small holes, even when mixed with very thin oil; and the very cooling of a bearing will cause the graphite, mixed with oil, to clog up the oil hole to an extent that may not be remedied by the re-heating of the bearing, after the stoppage of the lubricant. On the same account, it is essential that the oil conduit to any moving part be ascertained to be of suitable shape and proportions before the use of any solid lubricant is attempted.

297. Requirements in Gas Engine Lubrication. It is essential in a gas engine cylinder that the oil should be constantly supplied at a uniform rate which is capable of regulation; and for the purpose of properly meeting this requirement a number of different kinds of dripping and filtering oil cups have been devised and put into practical use.

As has been repeatedly pointed out by gas engine authorities, the apparently long period spent in finally perfecting the motor was due almost entirely to the fact that the subject of proper lubrication was not fully understood. With the ordinary oils, it was impossible to obtain anything like a satisfactory

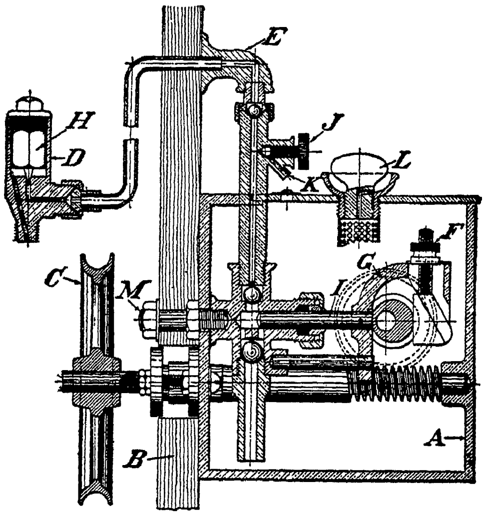

FIG. 145.—SECTION THROUGH A TYPE OF POWER-DRIVEN OIL PUMP.

A, oil reservoir; B, dashboard of car; C, pulley driven by belt from engine shaft; D, gravity valve on distributor; E, outlet elbow; F, set screw to regulate stroke of plunger, I; G, plunger bracket bearing against eccentric, which is on the gear operated by worm, or endless screw, on the shaft or pulley, C; H, weight of gravity valve, D for holding outlet port normally closed, and rising under pressure of oil from pump; I, plunger of pump drawing oil from reservoir, A, through ball valve, and expelling it through ball valve to outlet, E; J, test cap for testing flow of oil; K, oil outlet for test cap; L, filling plug and strainer; M, stud bolt for securing machine to dashboard.

(Paragraph 298)

speed and power efficiency, and only when the superior properties of mineral oils were better understood was the present high degree of perfection in any sense obtainable. Even to the present day the question of proper lubricants for gas engines is most essential, and, as has been pertinently remarked, "the saving of

a few cents per gallon in purchasing a cheaper grade of oil for this purpose is the most expensive kind of economy imaginable."

298. **Oil Pumps and Circulation.** With the use of high-speed gasoline engines, it has been found necessary to use a forced circulation of the oil in order completely to lubricate the

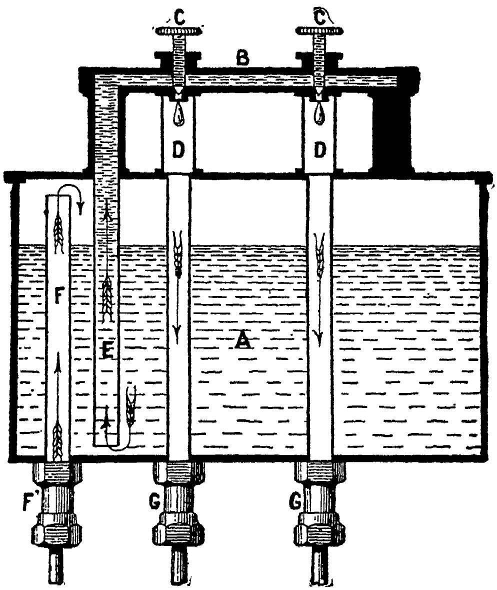

FIG. 146.—TYPICAL FORCE-FEED LUBRICATOR, OPERATING BY AIR OR GAS PRESSURE, INSTEAD OF A PUMP.

The parts are: A, oil reservoir; B, distributing pipe; C, C, valve screws for regulating flow of oil to parts, through leaders, D and D; E, standpipe through which oil is forced by air pressure; F, standpipe admitting gas from crank case of Engine; F′, union for pipe from crank case; G, G, unions for pipes to various parts of the machinery.

(Paragraph 298)

interior of the cylinder. The most usual method with high-powered multiple-cylinder engines is to employ a positively-geared pump to force the oil through adjustable sight-feed conduits to the various moving parts. Such pumps, operating in ratio to the speed of the engine, of course supply lubricant

more rapidly as the number of revolutions increases, and slow down as it decreases. Thus, a perfect supply is maintained, as required, on the one hand, and flooding is prevented on the other. There are several efficient types of oil pump on the market, all working on the same principle of forcing the oil to the moving parts in such volume as may be determined by the adjustment. One or two inventors have produced devices of this kind operated by compressed air forcing the oil out of a tank, the degree of compression being determined by the speed of the engine operating the air pump. A pump, illustrating the first method, is shown in *Fig.* 145, and a force feed reservoir under air pressure in *Fig.* 146.

299. **Lubricants for Motor Cars.** In choosing lubricants for any of the moving parts of a self-propelled road vehicle it is especially essential to see that the quality of resisting temperatures, both high and low, without change of useful consistency, should be present. An oil that will congeal at ordinary low temperatures, or become thin at ordinary high temperatures, is, of course, entirely unsuitable for this purpose. Furthermore, the quality of flowing freely from well-adjusted oil cups should be assured, since the high speed of automobile engines, engendering a constant vibration affecting more or less the adjustment, requires that the oil supplied should be a subject of constant solicitude. To state the matter in a few words, all competent authorities seem to agree that the conditions of automobile operation require the use of mineral oils on all moving parts, and the avoidance of any mixture with animal or vegetable oils, which, although frequently used in stationary engines, cannot but result in inconvenience, not to say disaster, in automobile practice.

Since most manufacturers of motors and vehicles furnish moderately full directions for dealing with the question of lu-

brication, it will hardly be necessary to add more to the principles already laid down. If the automobile driver constantly bears in mind the fact that an oil suitable for one portion of his machinery is not of necessity suitable for every other, and will observe the conditions essential to maintaining the oil used at its proper consistency, he will have little trouble upon this score.

300. **Points on Lubrication of Motor Vehicles.** The first important consideration involved in preparing a carriage for a run is to see that the moving parts are properly lubricated. Every carriage or motor is sold with directions for providing for this necessity, the rate of oil consumption and the quantity being specifically designated. The principal parts which it is particularly necessary to keep thoroughly oiled are the cylinder pistons, the bearings of the crank shafts and fly-wheels, the differential gear drum and the change speed gearing.

Since on most well-built motors and carriages the moving parts are supplied with lubricating oil by means of sight feed oil cups, of familiar design, it is necessary to do no more than to see that the required level of oil is always maintained. As specified by many motor carriage authorities, it is desirable to thoroughly examine and replenish the oil supply in the adjustable feed cups at the end of about every thirty miles of run. Another consideration of importance in this particular is that before replenishing the supply of oil to such parts as the crank case or the differential gear, the old lubricant should be thoroughly evacuated by means of the vent cocks supplied in each case. The reason for this is that, after a run of from twenty to thirty miles, the oil in the moving parts is apt to be largely contaminated with dust and other impurities, which tend to interfere with its usefulness as a lubricant.

CHAPTER XXV.

HINTS ON MANAGEMENT AND SUGGESTIONS FOR EMERGENCIES.

301. **Fire Risks and Precautions—Gasoline.** The greatest care is necessary in dealing with the highly inflammable fuels used in internal combustion engines. Gasoline or benzine must never be opened or poured from one vessel to another while a lamp or fire is burning in the same or a neighboring room. If such work cannot be done by daylight alone, *incandescent electric lights* only should be employed. Kerosene must be handled with almost equal care, should be kept in stoppered cans, and only opened under the same conditions as gasoline. Should a little of either fuel fall on the floor, it must be instantly wiped up. A box of fine *dry* sand, big enough to hold a reasonably large scoop, should be in every gasoline engine room, for fire extinguishing purposes, or for absorbing drippings. Keep the box full, the scoop in it, and the lid closed. Water will only increase a fire occasioned by petroleum products, the flames spreading on the water. On the other hand, alcohol flames are extinguished by water.

302. **Fire Risks and Precautions—Gas.** Before opening any part of a gas engine, it is necessary to go around and examine all connections and see that they are shut tight. After closing everything it is advisable to run the engine around a time or two by hand or by compressed air, to exhaust any gas or vapor remaining within the cylinder, before taking off the covers. Have everything opened and well ventilated before

bringing a light near. If possible, use only a portable incandescent lamp attached to a flexible cable. Do not seek leaks with a naked flame.

303. **Ventilation.** Owing to the practical impossibility of keeping gas-mains and connections free from some leakage, it is necessary to have a well-ventilated engine room, wherever internal combustion engines are installed. For this reason, wherever possible, they should not be placed in a cellar. Suction fans should be employed in preference to blowers, so that the foul air may be drawn out, not forced into corners and crevices.

304. **Leakage.** Leaks around mains, etc., are easily detected by means of a lather of soft soap and water, the bubbles indicating the leak. In screwed iron pipes, if previously pulled up good and tight, a leak may generally be stopped by caulking lead wire into the threads. Leaks on lead pipes should be soldered, the gas being previously shut off.

305. **General Care of Engine.** All bright and polished parts should be kept clean and shining; painted and non-polished parts should not be allowed to accumulate dust, oily dirt, etc. When the engine is standing, and especially when overhauling, little plugs of clean teased waste should be used to prevent the entrance of dirt into oil holes, etc. Some strands of spun yarn or sennet soaked in tallow, should be laid each side of the crank pin brasses and between the crank webs and main bearings, to prevent grit from getting into those important journals. Never use emery on brass or lacquered work, a good metal-polishing paste or whiting will give a much better result and will not scratch. Always scour rods, etc., one way, a connecting rod always looks better when polished around than lengthwise.

306. **Overhaul of Engine.** No stated time can be set as the proper interval to elapse between overhauls. So much depends upon the quality of the fuel used and the nature of the lubricant. Two or three months is the *maximum* time, in general cases, where efficiency is desired.

307. **Tightness of Cylinder.** It is necessary to keep in good order those parts upon which depend the tightness of the engine, such as the cylinder and piston, the cover and valve joints, the ignition apparatus and all valves. Leakage causes loss of power and defective compression, with consequent waste of fuel.

308. **Care of Cylinder.** The cylinder bore and piston surfaces become coated with a glaze or hard skin through rubbing on each other. This glaze prevents wear and care should be taken that it is not abraded: to that end neither the cylinder nor the piston should be polished with emery, brick dust or other abrasive, but should be scraped clean of oil, charred matter and dirt by means of *copper* or *bronze* tools, and *washed* clean with petroleum.

309. **Piston.** A solid piston, with Ramsbottom or snap rings, is regarded as superior to one of the built-up pattern; the bolt-heads securing the junk-ring or follower of the latter type frequently retaining sufficient heat to cause premature ignition. With the first type, at least four rings should be fitted. A long piston is indispensable to a gas engine, as it has to serve as cross-head guide; a short one tends to tilt in the bore wearing it oval.

310. **Piston Rings.** They should be taken out and cleaned each time the engine is opened. If set fast, they may be loosened by hand with the aid of a little kerosene. The ring next the cylinder head will first require renewal, but Ramsbottom

rings can generally be expanded a little by peening. In setting them out, the ring should be hammered all around its inner circumference, the blows slightly heavier opposite the split; care being taken that each blow falls in the middle of the width, and at equal distances apart, to avoid distortion. A thin ring is superior to a thick one, and the splits should be V or Z-shaped instead of straight across, all breaking joints with one another.

311. **Joints.** The importance of tight joints is apparent; to secure this desirable point, in many engines the valve boxes, etc., have ground joints, being fitted "metal to metal," either without any joint, or at most with a thin luting of red-lead. Otherwise, joints should be made of asbestos, either millboard or cloth with wire gauze insertion. These joints should first be cut out exactly to size, using a carpenter's chisel or gouge, and saddlers' punches for the bolt holes. Next they should be soaked in water to soften them, the cleaned surface on the cylinder being well oiled meanwhile with ordinary boiled or raw linseed oil, to make the joint adhere. When the joint is placed on the studs, its outer face should be well painted with graphite and water, a plentiful dusting with dry graphite being desirable. The cover or head is then put on and tightened up, the nuts being gone around and followed up as the engine warms. The oil makes the joint adhere to the cylinder, while the graphite lets the cover leave it without tearing. All projections of the joint, inside the cylinder, should be cut away as they may burn off; it is judicious to cut the joint well clear of the cylinder bore for this reason. All oil should be wiped off the studs before putting on the nuts, as this may gum and hold the nuts fast.

312. **Valves.** These are largely made of steel, although some makers of large engines use cast iron. They should be kept in first class order from motives of economy of fuel, an in-

spection being made monthly even if they do not betray signs of rapid wear. Especial attention should be given to the exhaust valve, on account of the high temperatures in which it works. Care should be taken that no valves get dirty, rusty or overheated; their stems should be gauged to see that they are not bent, also that they do not fit their seats too tightly, as they may expand and stick when working. If the stem leaks, the seat should be reamed out and bushed or a larger stem fitted. If the valve springs weaken through long use or overheating, they should at once be replaced, to save loss of compression, etc. As it is necessary that the new ones should be of the same strength as those originally fitted, spare springs should be obtained from the makers.

313. **Regrinding Valves.** The process consists in rotating the valve upon its seat, by means of a brace or screw-driver, an abrasive agent being smeared upon the parts in contact. This wears valve and seat to smooth polished surfaces, and should be prolonged until all specks and marks are removed. Ground glass is a much better material than emery, cutting much cleaner; brick-dust or pumice powder should be used as a finisher. It is necessary to rotate the valve first one way and then the other to grind it evenly. Deep scores require to be removed by file or scraper, or the seat and valve may require machining.

314. **Valve Gear..** Take notice of all marks on cog-wheels, valves, etc., when stripping the engine, else mistakes will occur in replacing. In the gearing driving the two-to-one shaft, it will generally be found that the pinion has a dotted tooth, marks or figures being placed on two teeth of the gear-wheel; in setting up, put the one marked tooth between the two marked

teeth on the other wheel. With multi-cylinder engines, notice must be taken of the setting of each separate valve gear.

315. **Governor and Valve Gearing.** These parts should be carefully and regularly oiled, without excess of lubricant; in order to prevent clogging or gumming, leading to sluggish action, an occasional dose of kerosene should be given to all parts, especially the small pins and links about the governor. Where small capped oil cups are fitted on a shaft or inertia governor, they should be filled, at the commencement of each run, with vaseline or mica grease.

316. **Adjustment of Brasses.** In view of the shocks to which they are subjected, the various parts being likely to jar loose, all bearing-bolts should be set up good and tight; unless the engine is very small, a hammer should always be used on the spanners. The various bearings should be as tight as possible, as back-lash or lost motion tends to make a heavy knock or pound in a gas engine. Discretion must, however, be observed in making adjustments, as the piston pin or cross-head expands considerably under the high cylinder temperatures, and the connecting rod big-end should be always movable with a bar.

317 **Nuts Set Fast.** Cylinder cover nuts and those on the piston-rod not infrequently are difficult to remove; they may be loosened by the following means. A piece of iron bent hexagon like a ring spanner, which fits the nuts loosely, is made red hot and placed around the nut. This will generally expand them sufficiently to loosen them. Always have a ring or box-spanner for these nuts; an open wrench will often pull the corners off and deface the nut. The use of a caulking tool is unworkmanlike.

318. **Amount of Cooling Water.** The tanks should be capable of containing 45 to 60 gallons of water per indicated horse-power, the inlet temperatures being about 60° Fahr., and the outlet 140° Fahr. Larger allowances should be made with a heated engine room, or in warm climates. The hourly flow of water through the jacket should be 5 to 6 gallons per horse-power.

319. **Leaks in Water Jacket.** These may be stopped by means of a rust-making solution, say ½ lb. sal-ammoniac to 1 gallon water, letting it stand in the jacket all night. Blow-holes may be filled with a cement made of cast iron borings, sal-ammoniac and sulphur, made into a paste with fresh water.

320. **Non-Freezing Solution.** When laying off an engine during cold weather, it is advisable to fill the jackets (and radiator of a motor vehicle) with a non-freezing solution. A saturated solution of chloride of lime ($Ca\ Cl_2$) at the rate of 10 lbs. chloride to one bucketful of boiling water, is recommended. Let the brine settle, and strain it through a cloth before pouring into the jacket.

321. **Quality of Cooling Water.** The best for the purpose is rain water, collected from the roofs of the buildings and strained. City water usually contains lime salts, which form incrustations within the water jacket, like the scale in a boiler or kettle. This incrustation is harmful; being a non-conductor, it raises the temperature of the cylinder to the detriment of its lubrication, and also tends to choke the passages. River water is apt to contain mud, dangerous for the same reasons.

322. **Treatment of Water.** Conveniently placed cocks on the lower parts of the jackets will serve to blow out loose sediment or non-adhering scale. Careful settling of water before-

hand will generally eliminate the dangers from mud. The monthly injection of one pound of washing soda per 15 cubic feet of cooling water capacity in the tanks will generally convert the lime salts into soluble sludge, which may be blown out through cocks on the base of the tanks and those on the jackets.

323. **Removal of Scale from Jacket.** Incrustation may generally be removed from within the water-jacket by means of a 20 per cent. solution of hydrochloric (muriatic) acid. The jacket is filled with the acid and let soak for three or four hours, to dissolve the scale, which may be blown out as sludge. Care should be taken to avoid burns from the acid, also not to inhale its fumes. The jacket should be carefully washed out with water afterwards.

324. **Arrangement of Tanks.** It is not advisable to use reservoirs having a larger capacity than about 500 gallons, the usual diameter being three feet. Such tanks are fitted in series, the hot water entering at the top of the first, a pipe leading from its bottom to the top of the second, another pipe from the bottom of the second to the top of the third, and so on; the water supply to the jacket leading from the bottom of the last tank. If the natural circulation of the water be not sufficiently rapid, a small belt-driven centrifugal pump may be used to promote the flow through the jacket.

325. **Adjustment of Ignition.** Those engines supplied by good-class firms are always tried on the brake before leaving the shop. Still, as the quality of gas differs with every city, it is clear that some local adjustment must be made to suit the varying richness of the gas. No adjustment should be made without the use of the indicator, and periodical inspection by an expert is advisable.

326. **Starting a Gas Engine.** It is advisable to follow a regular routine, in order to prevent the omission of any detail, which may lead to mistakes and confusion. The following may be recommended:—

1. Oil the engine all around, trying the valve gear and governing mechanism, to see that all is clear and workable.

2. Inspect the cooling water supply, see that all cocks are open, and that the jacket drains are closed.

3. Open drain cocks on exhaust and gas-pipes to liberate any condensed water.

4. Light the ignition flame, if fitted with tube ignition, see that the sparking circuit is closed, if so fitted, placing the spark control in its backwardmost position, retarding the spark as much as possible. (See separate paragraphs on ignition.)

5. Open cock of valve box on engine or the test cock of the gas pipe.

6. Open the gas-supply cock from the meter, distending the bags, and forcing the anti-pulsator diaphragm out. As gas issues from the test-cock, apply a match to ascertain the quality of the gas, the flame being allowed to burn until it has gradually changed from a blue color to a bright yellow.

7. Set the engine in motion by means of the starting apparatus, the gas regulating cock being slowly opened to the proper mark on the dial. If no starting gear is fitted, pull the fly wheel round by hand until an explosion occurs. Never put the feet on the spokes when starting, or a bad accident may happen.

8. When the engine is properly running throw out the starting gear.

9. When the starting gear is out, bring the gas cock slowly to its full opening, and adjust the spark to suit the load.

327. Starting an Oil Engine. As the methods of vaporizing the oil vary considerably in the different makes, it is impracticable to formulate set rules. The following may be taken as hints rather than as instructions.

1. See that all strainers are clear and that the tanks are perfectly clean and full of oil.

2. The lamps and ignition device should be cleaned, and got ready, the oil pump being tried at the same time.

3. Light the lamps for heating the vaporizer or igniter, as in the Priestman or Hornsby-Akroyd.

4. Lubricate the engine thoroughly, testing all oil cups, and trying the governor gear by hand.

5. When the vaporizer or igniter is at the proper heat, usually a cherry red, the engine is ready to start.

6. Set the engine in motion, either by the starting device or by hand; in the latter instance, compression may be relieved by holding the exhaust valve open by hand.

328. Starting a Gasoline Engine. In addition to seeing that the reservoirs for gasoline and oil are full, that all connections are open, and that the sight feeds are working properly, attention must be paid to the following:—

1. That the sparking circuit is closed, involving examination of all switches. If the ignition apparatus consists of batteries and coils, trials should be made to ascertain whether the current passes at the proper time. This is done by completing the circuit with the contact on the secondary shaft, which should produce the characteristic hum or buzz caused by the action of the coil. A magneto apparatus is not so likely to get out of order and does not call for so frequent an inspection.

2. That the lever on the spark control quadrant stands at the extreme "back" position, retarding the spark to the utmost.

3. That the carburetter control lever is moved to the "open" position for insuring the *richest* mixture at starting, in order to develop initial power under the low suction prevailing as the engine first moves.

4. That the cock on the tube between fuel tank and carburetter is opened.

5. That the carburetter is in working order. This is ascertained by depressing the protruding end of the valve spindle or flusher; this act depresses the float, permits liquid to enter the chamber, and prevents the carburetter valve from sticking.

6. These preliminaries having been observed, it remains only to crank or bar the engine round. Under favorable conditions it is necessary to turn the engine over but once, through the suction and compression strokes, to the point of ignition. It will then take up the cycle and run without further assistance.

329. **Defective Compression.** Faulty compression is likely to prevent the ignition of the charge. The deficiency or otherwise may be ascertained by turning the engine around to the point of compression, when all valves are or should be closed. If but slight resistance be encountered, it is apparent that the charge is escaping through one of the valves or past the piston. The various channels of escape may be investigated as follows:

330. **Leaky Valves.** The valves, usually closed by their springs, may become hung up, from various causes. The stems may be clogged, which can be ascertained by manipulating them by hand or by a lever; this may be remedied by taking apart

and cleaning off the caked oil, the same applying to an obstruction which may prevent the valve closing. A worn valve may leak, this is only to be remedied by grinding in or renewal. In a new engine, the stem of the valve may bind in the seat, through fitting over-tight, which may be remedied by easing the stem with fine emery cloth and applying a little lubricant, cylinder oil for inlet and kerosene for exhaust valves.

331. **Leaky Exhaust Valve.** Other causes may militate against the effective operation of an exhaust valve. The spring may weaken through over-heating, or slackening of its compression nut, so that it has not sufficient tension to keep the exhaust valve closed against the suction of the charging stroke. This is remedied by renewal of the spring, tightening of the compression nut, by inserting a washer under the spring, or weighting the spindle (for a temporary repair). Lack of end play between the roller or wiper on the cam shaft and the valve stem, due to expansion of the latter, may prevent the valve from seating itself at all. This may be obviated by filing or regulating the contact.

332. **Leaky Piston.** The passage of the compressed charge, past the piston, is indicated by a whistling sound. This may be due to broken or worn rings, or to wear of the cylinder. The piston rings may be dealt with as mentioned in par. 310; if the cylinder is badly worn, reboring is likely to be necessary.

333. **Care While Running.** The engine having attained its normal speed an eye should be given to the governor, to see that it is acting properly, and that racing or "hunting" need not be feared. The electric spark must be set forward and the throttle partially closed. The cocks of the cooling water supply

should be set to the mark so as to maintain the proper cylinder temperatures. The working of the sight feeds should be inspected from time to time, to see that the bearings are getting their proper oil, and the crank pin and main bearings should be "felt around" every half hour. A very short experience of the engine room will enable the attendant to feel the crank pin brass while running, without risk of getting nipped, while absolute certainty of the condition of the journal will result from physical contact.

334. **Stopping Gas Engine.** 1. Close cock between meter and gas bag to avoid distension of the rubber bags.

2. Actuating the half compression or relief-cam, if fitted, to prevent reverse motion owing to compression.

3. Close gas cock between bags and engine.

4. Shut off burner of hot tube ignition.

5. Shut off cooling water supply; running water from jacket if weather be cold, or engine is going to be laid off.

6. Let the engine rest with crank at outer dead center of its compression stroke, all valves being then closed.

7. Close all sight-feed lubricators, remove worsteds or wicks from syphons, and shut down all oil box lids.

335. **Hot Tube Ignition.** Platinum and porcelain tubes are being superseded by a tube of nickel alloy, which is cheaper than the former and less fragile than the latter. The tube is heated by a Bunsen burner, and usually takes five or ten minutes after lighting to obtain its proper cherry red color. Care should be taken that the flame from the burner is blue, regulating the air admission, if necessary, by the sleeve over the air opening. A white or smoky flame, with a sooty odor, is an evidence of insufficient air supply; this color may also be caused by igni-

tion of the gas within the air space. If this happens, blow the burner out and relight it properly. A bluish or greenish flame has the highest temperature. If the flame flies back to the holes in the burner, it is short of gas.

336. **Electric Ignition.** As has been already stated, it is necessary to have the spark set late at starting, this is to avoid a premature explosion, causing a sharp revolution of the engine in the wrong direction. This condition of open throttle and late spark should never occur, except at starting, as it tends to waste of fuel, and the heat of the exhaust, owing to high terminal pressure, may damage the exhaust valve.

337. **Faulty Tube Ignition.** A porcelain tube may break at starting either through imperfect fitting or from the presence of water in the cylinder. A metal tube may carry away at the same time, generally because it is worn thin by use and cannot withstand the stronger explosion of the rich mixture at starting. A tube may also be choked by an internal obstruction or may be rendered faulty by leaks in its joints or in its body, whereby gas escapes and does not ignite. This latter is detected by a whistling sound.

338. **Water in Cylinder.** Water may be present in the cylinder from various causes:

1. A leak between the cylinder and the water jacket; betrayed by bubbles rising in the water tank at the time of explosion. This may necessitate the renewal of the cylinder or at least its working barrel, although plugging a hole or remaking a joint will generally suffice.

2. Bad arrangement of piping, causing entrained water to be brought in with the gas, or condensed from the exhaust and flow-

ing back. This is remedied by trapping the pipe or by elimination of bends and pockets on the exhaust.

3. Condensation of water created by the union of hydrogen and oxygen within the cylinder, or by electrolytic action, drops of water forming between the contacts of the spark plug.

Whatever its origin, water retards the explosion through chilling the gases and often renders it difficult to start the engine. To lessen the first cause of trouble, the cooling water cocks should always be shut when the engine is stopped. The cylinder drain cock should always be opened when starting. If no drain cock is fitted, the attendant difficulties can only be overcome by pulling the engine round and round and making ceaseless efforts to start it.

339. **Overheated Bearings.** These may be caused by undue tightness in setting up, by too much play, by lack of oil or by the use of a poor lubricant. The watchfulness of the attendant, feeling all the bearings while the engine is in motion, is the surest guard against anything serious developing. Liberal oiling at short intervals will often cool any bearing if applied as soon as a change in temperature is noted. If this be inadequate and it is undesirable to stop the engine, a spray of soapy water may be effective.

Where brass bearings are fitted, a little flowers of sulphur mixed with the oil is often effective; this should not be used on white metal or babbitt bearings, as the sulphur abrades the anti-friction metal.

If the bearing is allowed to get properly overheated, the characteristic frying-pan smell of burnt oil will be perceived. If things have got so far, the engine must be slowed or stopped, as oil will only be burnt up, and clog all channels and oilways in the bearings. The temperature should be reduced by apply-

ing wet lumps of cotton waste and spraying with water. A small engine, when overheated, should have the affected part opened up, cleaned out, and the binding surfaces eased by scraping. If the heating occurs after adjustment, as is most likely, slacking back the nuts will generally remedy the trouble. In this case, a tin liner or shim should be fitted between the parts, so that the bolts are still in tension.

340. **Overheated Cylinder.** This may be due to stoppage or diminution of the cooling water supply, either through choking of the pipes or of the jacket. If the discovery is not made until the cylinder is very hot indeed, it is best to stop the engine and wait awhile, as the sudden turning on of cold water into a red hot cylinder may easily crack the cast iron. Restore the circulation gradually as the temperature approaches normal.

Again, it may be mentioned that a one-to-four solution of hydrochloric acid, used for washing out the jackets, will remove calcareous deposits. Of course, the jacket should be sluiced out with plenty of fresh water before coupling the water service again.

341. **The Spark Plug.** Formerly, nearly all ignition troubles were attributed to poor spark plugs. Now, we understand that such troubles arise from many other sources. Nevertheless, a spark plug is a delicate instrument, and one frequently deranged.

The commonest source of trouble is short-circuiting, due:

1. To breaking down of insulation, cracking in porcelain plugs, oil-soaking, deterioration of cement filling, or metallic impurities in mica plugs.

2. To fouling with soot between the electrode surfaces and spark points.

Troubles due to the first cause demand renewal of the plug.

Fouling with soot may generally be removed with gasoline.

Preventives of fouling are:

1. An annular space between the core insulation and the outer shell, producing a vortex, as is alleged, and allowing piston suction to remove deposits.

2. An outside spark gap, which will generally suffice to insure a spark, but it does not prevent fouling between the spark points.

342. **Circuit Wiring.** The principal points for examination are:

1. The terminals and binding posts.

These should be firmly secured—all looseness being avoided—although crushing of the wires should be carefully guarded against.

2. The insulation, which should be examined for breaks, flaws or rubbed areas. By this means leaks and short circuits will be avoided.

343. **Defective Fuel Mixture.** It frequently happens that too *rich* a mixture will not ignite readily on cranking, and as a consequence, the engine will not start. It is necessary, then, to reduce the mixture, allowing more air to enter the carburetting chamber.

If the engine starts with a rich mixture, the result is liable to be seen in a heavy and ill-smelling smoke from the muffler. The color of this smoke will determine the nature of the trouble.

Dark-colored dense smoke indicates an excess of gasoline in the mixture, and may result from one of the following conditions:

1. A very rich mixture.
2. Imperfect combustion.
3. Defective ignition.
4. Either excessive or defective lubrication.
5. Overheating and consequent flashing of the lubricating oil.
6. A leaky piston.

The two most usual causes of dark smoky exhaust, however, are:

1. Defective carburetter action, due probably to grit under the inlet needle valve, or else to some derangement of the parts.
2. An over-rich mixture, which ignites imperfectly.

White dense smoke indicates an excess of oil or a resulting deposit of carbon soot in the cylinder, or a poor oil that is liable to flash at low temperatures.

Thin blue, or nearly invisible smoke indicates a normal mixture and good ignition.

An unpleasant odor in the exhaust is frequently mentioned as the one necessary evil of motor carriage operation. This is incorrect, as the odor most often indicates poor lubricating oil or too rich a mixture, involving waste of fuel. A good mixture, perfectly ignited, in a cylinder lubricated with high test oil, should have no very bad odor.

344. **Reducing Smoke in the Exhaust.** Smoke from the exhaust being a sure indication of oil-flooding or too much gasoline in the fuel mixture, demands attention to the *oil feed* and *carburetter,* as follows:

1. Reduce rate of oil feed, if the smoke indicates oil. If this is the sole trouble, the smoke will decrease after a few revolutions of the fly-wheel.

2. Restore the oil feed nearly to normal and adjust the carburetter.

3. Examine the air inlet of the carburetter, and cleanse the gauze screen of any dust. This will restore the air supply.

345. **Dangers of a Smoky Exhaust.** A smoky exhaust, indicating the presence of excess oil or carbon deposits in the cylinder, should serve as a warning in one respect. The soot formed is liable to take fire and smoulder, causing pre-ignition, particularly under heavy loads. If, after other relief measures have been tried, the nuisance persists, the cylinder interior should be cleaned at the earliest opportunity. In cold weather considerable watery vapor appears in the exhaust.

346. **Causes of Defective Mixtures.** An over-rich mixture—one containing an excess of gasoline vapor—may be caused by any one of several conditions, prominent among which are:

1. An air inlet clogged with dust or ice on the gauze.

2. A piece of grit or other object preventing closure of the needle valve.

3. A leaky float which has become partially filled with liquid gasoline, and is, therefore, imperfectly buoyant. This should be repaired by soldering.

A poor mixture may be caused by:

1. An excess of air drawn through some leak in the air pipe.

2. Water in the gasoline.

3. A feed pipe or feed nozzle clogged with lint, grit or other obstructions.

The quality of the mixture may generally be determined from the effects on the operation of the engine. If it is not obvious in this manner, it may be determined by actual test.

This may be done by removing the peep cap or plug from the cylinder, and applying a match. A too-rich mixture burns yellow, one too poor will not ignite or else will be faintly blue, one correctly proportioned will cause an explosion. If it seems too poor, flooding the carburetter will prove whether the impression is correct or not.

347. **Causes of Back-firing.** Back-firing, or pre-ignition, may occur under several conditions. Prominent among these are:

1. An early ignition, at or before the backward dead-center of the crank, before the cycle is established, as in the act of cranking the engine for a start. The result is then a *back-kick,* or reverse revolution. This can only emphasize the necessity of retarding the spark at starting, so that it will not occur until the dead-center is fairly passed over, and the piston has begun the outstroke.

2. Overheating of the cylinder walls, due to insufficient heat radiation (in an air-cooled engine) or too little jacket-water (in a water-cooled engine). This should emphasize the necessity of keeping the water supply sufficient for all needs, and of assuring the perfect operation of the circulation system, pump, radiator, etc., before starting the engine.

3. Soot deposits within the combustion space, due to carbonization of excess oil, etc. Such deposits will readily ignite and smoulder, and will thus furnish an almost certain source of ignition, during the compression stroke.

4. By attempting to increase the power-output of the engine, when operating on a heavy load, by advancing the spark too far. In this case, the conditions causing back-kick at starting are closely approximated as the engine is running too slow for an early spark.

348. **Water in the Carburetter** will often prevent starting of the engine, and will always impair its efficiency. Water is very frequently present in gasoline, and, particularly when the tank is low, is liable to get into the pipes and carburetter. Every carburetter has a drain cock at the bottom to let off the water that settles from the gasoline.

The natural result of water in the carburetter is impaired or interrupted vaporization of gasoline.

In cold weather, also, the water is liable to freeze, preventing the action of the carburetter parts and clogging the valves. Ice in the carburetter can be melted only by the application of hot water, or some other non-flaming heat, to the outside of the float chamber.

It is not at all necessary to drain the carburetter before every starting, but after a prolonged period of inactivity it is desirable to give the water an opportunity to escape.

A strong presumption of water in the carburetter is established when the engine starts, runs fitfully, or irregularly, and finally stops.

349. **Stale or Low-Degree Gasoline.** Another condition that will produce some of the same symptoms is low grade or stale gasoline. These two varieties of spirit are practically identical, in effect at least, both being characterized by a lower specific gravity than is required for readily forming a fuel mixture. Gasoline, or petrol spirit, as it is called in England, should have a specific gravity of about .682, or 76°B. Some English authorities recommend spirit having a specific gravity of from .72 to .74, or between 65° and 59°B, virtually what is known in the United States as high-grade benzine. Hydrocarbon spirits of lower degree on the Baumé scale become increasingly difficult to vaporize.

Gasoline, being a volatile essence distilled from petroleum oil at temperatures ranging between 122° and 257°F., and boiling at between 149° and 194°, on the average, is a compound of several spirits of varying density, gravity and volatility. Chemically, it is represented by formulæ ranging from C_5H_{12} to C_7H_{16}, with the average C_6H_{14}. It follows, therefore, that, unless stored in an air-tight vessel, the lighter constituents are liable to escape, leaving a residue that will show a registry on the Baumé scale below that found easiest to vaporize.

This is the process that occurs in the carburetter, if gasoline is allowed to stand in it for any length of time. It is always best, therefore, after standing for a protracted period, to drain the carburetter.

Of course, if the tank is found to contain only low-degree liquid, the only alternative is to empty it and refill with a supply of the proper quality.

350. **Causes of Failure to Start.** If all preliminaries, hitherto specified, have been carefully observed, and the engine shows good compression at cranking, the probable causes of trouble should be sought:

1. In the sparking plug.

The spark-points may be too far apart; there may be fouling between them; the plug may be short-circuited, or the insulating layer of porcelain or mica may be broken down.

2. In the carburetter.

The spray nozzle may be clogged; there may be water in the float chamber; low grade gasoline may be used; too much or too little air may be admitted. The supposed carburetter trouble may be located in the fuel tank or supply pipe; in the throttle or may be due merely to faulty valves.

3. In the battery.

The battery may be run down or polarized.

4. In the circuit wiring or connections.

There may be a short-circuit, due to a broken wire or defective insulation, or there may be a looseness at some binding-post.

5. In the vibrator of the coil.

There may be a defective adjustment of the vibrator, preventing it from responding to the strength of current in use, or the vibrator may be broken loose.

6. In the interior of the coil, as previously explained.

351. **Fouling of the Spark Plug.** Persistent failure to start, when buzzing of the induction coil vibrator indicates that the electric circuit is in working order, may be attributed to fouling of the spark plug. Fouling may consist of liquid oil or soot. Both give most trouble at starting.

Fouling may be removed:

1. By using a well-made spark-gap arrangement.

2. By a temporary spark-gap, made by disconnecting the lead wire of the plug and holding its end at a sufficient distance to allow a visible spark to leap from it to the plug core.

If this proves ineffective, the plug should be unscrewed and examined. Any visible fouling may then be removed by rubbing the insulation with fine emery paper until the bright surface of the porcelain is visible, taking care not to impair the surface.

352. **Testing the Spark Plug.** If no fouling appears, the plug may be laid upon the cylinder or frame so that its case only is in contact, and thus grounded, and on cranking the engine, the spark may be seen leaping between the points.

If a spark does not appear, it is probable that, with the ignition circuit in working order, there is some breakage or short

circuit in the body of the plug. This, of course, necessitates its removal and the substitution of a new one. If a spark appears, the search for trouble must be continued to other apparatus.

353. **The Spark Points of a Plug.** Very frequently a perfectly sound plug will fail to spark, simply because the spark points, for some reason or other, have been too greatly separated, or else because the battery is nearly exhausted. In either case the trouble may be overcome by bringing the spark points nearer. For average strength of battery, the distance between the points should be about 1/32 inch, and practically never more than 1/16 inch.

354. **Failures with Four Cylinders.** Unless the ignition circuit is elsewhere disarranged—in battery, coil or wiring—failure to start in a four-cylinder engine is probably due to causes other than foul or defective spark plugs. It may happen, however, that one, or even two, of the cylinders will fail to ignite. This condition will show symptoms similar to those caused by mis-firing, irregular movement and vibration.

355. **Testing for the Missing Cylinder.** In practically all four-cylinder engines made at the present day the cranks of the second and third cylinders are in line, and are set at 180° to the cranks of the first and fourth, which are also in one line. Consequently, the pistons of the second and third cylinders make their instrokes at the same time as the first and fourth make their outstrokes. As a rule, the order of ignition is: first, third, fourth, second, which is also the order in which the primary circuit is closed at the commutator through the primary winding of each coil in succession.

In order, therefore, to determine which cylinder, if any, is missing fire, it is necessary only to open the throttle and advance the spark lever to the running position, giving the engine

good power, and to cut out three of the four cylinders by depressing their coil vibrators. If the engine continues to run with coils 2, 3 and 4 cut out, cylinder 1 is evidently working properly. Depressing vibrators of 1, 3 and 4 shows whether 2 is working; of 1, 2 and 4, whether 3 is working, and of 1, 2 and 3, whether 4 is working. On discovering the faulty cylinder, its plug may be tested precisely as is the plug of a single-cylinder engine.

An exactly similar process may be followed in the search for a missing cylinder of a three or six-cylinder engine.

A missing cylinder may also be found by the low temperature of its exhaust pipe, provided the missing be long continued.

356. **Misfiring During Operation.** Occasionally, the missing of one or more of the cylinders will be noticed during the operation of the engine. This trouble may be recognized by irregularity of motion, gradual slowing down, and, generally, by *after-firing,* or explosions in the muffler. If, by the coil-cut-out test, just described, it be found that one particular cylinder is at fault, it is fairly probable that a faulty spark plug, a loose wire in the secondary circuit, or a sticking valve is the cause.

If the trouble cannot be thus located in one of the cylinders the inference holds; either that there is some general derangement of the ignition circuit, or that the fuel mixture is not right.

357. **Misfiring: Short Circuits.** Very frequently misfiring is caused by a short circuit, which is to say a ground, or an arcing gap between the two sides of the secondary circuit, at some point short of the plug terminals. This will, of course, prevent sparking at the plug, although, owing to the vibration

of operation in the other cylinders, the short circuit may occasionally be interrupted and the spark will occur.

Such a short circuit differs from an *extra spark gap,* in that the latter is *in series* with the plug gap, while the former gives a leak *in parallel* to it.

A broken-down coil, or one in which the insulation is weakened, allowing internal leaks and sparking, will cause misfiring for a time, and will very soon be of no use whatever.

358. Misfiring: Loose Connections. Loose connections of the wires at a binding screw, in either primary or secondary circuit, may cause misfiring, or irregular firing, in very similar fashion. The looseness may be small, or it may be excessive, and the condition in this respect determines the degree of interference in engine operation. Thus, a loose connection may allow the engine to run from rest to a moderately good speed before trouble begins, or the vibration of operation may interrupt the contact entirely. This only emphasizes the necessity of keeping connections tight. Spring connections are much used now.

359. Misfiring: Weak Battery. As we have already learned, a weak battery may prevent sparking between the plug points, and can be remedied in no better fashion—provided no extra battery be at hand—than by reducing the gap between the points. As a consequence, a weak battery is a frequent cause of misfiring.

Misfiring due to a weak battery may be diagnosed by the occasional apparent violence of the explosions, on account of frequent misses. A weak battery will cause misfiring most conspicuously when the engine has been run up nearly to full speed, and then suddenly drops, owing to irregular ignitions.

The reason is, obviously, that the weak battery cannot supply good fat sparks at a rate commensurate with the requirements of rapid operation. With a reduced spark gap and a slow speed, it may be able to continue operation for a limited period.

These principles apply, of course, to chemical batteries. When the current is obtained from a magneto or dynamo, the trouble—if traced to the source—is probably due to loose or worn brushes, a glazed commutator, or a short circuit somewhere in the armature, or around the brush holders.

360. **Misfiring at High Speeds.** Among other causes of misfiring at high speeds may be mentioned a faulty adjustment of the coil vibrator, giving extremely short *makes* of the primary circuit and slow rates of vibration, which cannot keep pace with the requirements of high engine speeds.

Loose circuit connections, shaken out of position as the engine speeds up, and weakened batteries are far more common causes of this mishap at high speeds, as already indicated.

361. **Misfiring: Defective Mixture.** A defective mixture will frequently occasion misfiring, on account of difficulty of igniting. Such a defective mixture may be one that is either too rich or too weak, and may be produced by a flooded carburetter, one in which sticking, or some similar disorder, prevents the feeding of sufficient gasoline spray for a good mixture.

In either case the ignition of the charge is slow, if it occurs at all, and the result is that unburned gas is discharged into the muffler, producing after-firing and reducing the power efficiency.

362. **After-Firing in the Muffler.** After-firing, or "barking," sometimes incorrectly called back-firing, and consisting of a series of violent explosions in the muffler, is commonly caused

by misfires in one or more cylinders, permitting the accumulation of unburned gas in the muffler, which is ignited by heat of the walls or by the exhaust of firing cylinders. Sometimes it may be due to a mixture that is too rich or too weak, and hence burns slowly, continuing its combustion after passing into the exhaust. It also occurs, not infrequently, when the spark is retarded to slow the engine before stopping. No particular harm results from this rather startling effect, since the explosion can seldom occur until the unburned gas comes into contact with the outer air.

363. **Running Down.** When the engine starts well, runs for a while, then slows down and stops, there are very many conditions to which it may commonly be attributed. Among these are:

1. Water or sediment in the carburetter.
2. Loose connections, break-downs, or any other disarrangement of the ignition, such as would otherwise interfere with starting.
3. A weak or imperfectly recuperated battery—frequently the latter—that suddenly fails to supply current.
4. A leak in the water jacket that admits water to the combustion space.
5. Seizing of the piston in the cylinder on account of failure of the cooling system. This may result, in a water-cooled cylinder, from:

    a. Exhaustion of the water.
    b. Stoppage in the pipes or pumps.
    c. Breakdown of the pump.
    d. Failure of the oil supply.

In an air-cooled cylinder seizing may result from:

    a. Insufficient radiation surface.
    b. Obstructed air circulation.

6. Heated bearings that seize and interfere with operation.

7. Poorly matched or badly adjusted new parts, particularly pistons, that cause heating, and perhaps seizing, from friction.

8. Lost compression from broken or stuck valves, leaky piston, etc., as explained in the succeeding paragraph.

364. **Low Compression Troubles.** Practically all the mishaps hitherto mentioned may occur with a good compression, which may be recognized on turning the starting crank. When little or no compression manifests itself as a resistance to the turning of the crank, it is certain that the operation of the engine will be defective, provided it can be started at all. If the engine loses compression after it has started, it will misfire and slow down.

Low compression means absence of a sufficient quantity of gas mixture to give a good power effect. This absence results from a leak in the combustion chamber, due to:

1. A sticking inlet valve—if the inlet be automatic—from an incrustation of oil gum. Sticking may be due to other causes also.

2. A pitted or corroded exhaust valve.
3. A weak spring on the exhaust valve.
4. A loose or open compression tap.
5. A leaky piston, due to:
   a. Worn or broken rings.
   b. Piston rings worked around, so as to bring the openings on their circumferences into line.
6. A blown-out gasket in the cylinder head.
7. A worn or loose thread at the insertion of the spark plug.
8. A broken valve or valve stem.
9. Worn or scratched sweep wall, due to lack of oil or the presence of grit.

10. A valve-stem that is so long as to touch the end of the pushrod when the engine is cold. The remedy for this is to file the end of the valve stem until a card may be inserted between its end and the end of the pushrod.

365. Unusual Noises. There are many troubles of varying gravity that are manifested by no other symptoms than noises, more or less regular, during the operation of the engine. Such noises always indicate trouble, and should not be ignored by the careful motorist.

There are certain rhythmic sounds that are always produced during the operation of a gasoline engine, and the motorist soon learns to recognize them. They are the regular rattle of the automatic inlet valves, the roar of the gears and cams, and the puffing of the exhaust.

Present-day engines are far less noisy than those built several years ago, principally on account of:

1. Better balance of the moving parts.
2. More efficient and better adjusted mufflers.
3. The extensive use of the mechanically operated inlet valves.
4. Better gears and cams.
5. The use of housed gears.

Unusual noises, indicating trouble, may be described as:

1. Knocking.
2. Squeaking.
3. Hissing or puffing.
4. Numerous irregular puffs and pops.

366. Knocking in the Cylinder. The form of unusual noise commonly described as "knocking" consists of a regular and continuous tapping in the cylinder, which is so unlike any sound usual and normal to operation that, once heard, it cannot be mistaken.

367. Knocking Caused by Over-Rich Mixture. Knocking, with all the features of that caused by an over-early spark, may sometimes result from an excessively rich mixture, which may ignite too slowly or too rapidly. Here, as in the general operation of the engine, the rule holds that spark-advance and charge-enriching amount to the same thing, so far as the results are concerned.

If retarding the spark from the extreme lead fails to overcome the knock, the mixture may be throttled with good probability of success.

368. Other Causes of Knocking in the Cylinder. The knock caused by a premature spark is a heavy pound. The knock caused by some other defects is often less severe. Among other causes of knocking may be mentioned:

1. Defective lubrication or burned oil, leading to a tendency to overheat and seize. This trouble develops rapidly, and demands instant attention, as soon as recognized.

2. Over-late or disordered ignition, producing an explosion during the suction or exhaust strokes. Such an explosion has very little force and is best described as a "pop."

3. Loose or broken piston rings.

4. Broken wrist, or gudgeon, pin in the piston. This is the part of the engine that receives a large share of stress in a high-compression engine, such as is used on most pleasure carriages at the present time.

5. Irregular wear in the cylinder.

As mentioned by numerous authorities, the placing of the spark plug in the exact centre of the combustion space occasions a peculiarly sharp knock, which may be stopped by advancing or retarding the spark from the one point of trouble.

This explanation of the trouble is questioned by others, and is probably over-rated.

369. **Knocking Outside the Cylinder.** Knocking, or long-continued tapping or pounding, is not always within the cylinder itself. The effect may result from several mechanical causes, such as:

1. Loose bearings at the wrist or crank pin, giving one knock at the moment of explosion, and another at the change of stroke.

2. Lack of alignment between the connecting rod and the crank pin or wrist pin, which forms a very serious source of trouble. An engine will run with its connecting rod and bearings out of line, but the trouble should, of course, be remedied at the first opportunity.

3. Loose, worn or broken parts at the bearings, in the fly-wheel or in some nut or bolt. Considerable trouble may be caused by a loose fly-wheel, which is a derangement particularly difficult to determine.

370. **Squeaking in the Engine.** Squeaking, evidently caused by the rubbing of one part upon another, is a sure sign of insufficient lubrication, probably in some bearing outside of the cylinder, although perhaps at the wrist pin of the piston. Faulty lubrication between the piston and cylinder wall would produce much more serious results than noise, as already stated.

371. **Wheezing.** A wheezing sound, evidently due to the escape of gas or air under pressure, and sometimes amounting to a squeak, is often caused by loose or worn piston rings or scoring of the cylinder bore. The causes of this trouble are, as already suggested:

1. Deficient lubrication, producing a tendency to seize.

2. Misalignment of wrist pin and crank pin, or a bent rod, causing the bore to wear oval. This trouble generally results from repeated back-firing, from an over-early spark and the other causes specified.

The signs of a worn cylinder bore or loose or broken piston rings, should be immediately observed. They indicate the most serious occasions of loss and failure possible in a gas engine.

372. **Hissing or Puffing Sounds.** While leakage at the piston gives forth a sound that may be described as "wheezing," on account of the imperfect venting of the compressed gas, the escape of such gas into the atmosphere is accompanied by hisses or puffs. Such sounds indicate the probability of leaks:

1. At the gasket in the cylinder head, if a joint exists above the piston.

2. At the insertion of the spark plug, due to a worn screw thread or washer.

3. At the valve seats, due to pitting or to an improper fit of the valve.

Leaks of this character are liable to occasion continuous cracking sounds during the firing stroke.

At least a moderate amount of care should be paid to the arrangement of the exhaust from a gas engine, for it will be amply repaid by the avoidance of many sources of trouble.

It has been found that a straight exhaust pipe, in length about 100 times the stroke of the engine, will produce a *scavenging effect.* The products of combustion will attain so great a velocity that they will create a suction in the combustion space of the cylinder, thus freeing it from the remainder of the burnt charge. If some sort of stratification is applied to the mixture, the admission valve may be set to open before the

conclusion of the exhaust stroke, thus blowing air into the clearance space, and assisting the scavenging action.

With mixed ignition governing, however, the unexploded charge is apt to communicate with both the hot exhaust and the fresh incoming charge, thus rendering early opening of the admission valve a cause for premature ignition.

The exhaust pipes should be as straight and free from bends as possible, the necessary curvature being made very easy. The most effective silencer is afforded by the attachment of a straight trumpet-shaped conical nozzle to the end of the exhaust piping, the cross-sectional area of this being proportional to the desired velocity of the gases. This velocity may be calculated as ranging from 2,500 to 3,000 feet per minute at the commencement of the exhaust.

In expanding from 40 lbs. terminal pressure to that of the atmosphere, the volume of the gases increases three-fold. The mouth of the nozzle should therefore be nearly twice the diameter of the exhaust pipe, and the length of the cone should be twelve times its initial diameter.

A steel muffler box is apt to act as a resonator or intensifier of sound, so the exhaust is best led into the bottom of a masonry well. The exhaust chamber should have a capacity of fifteen to twenty times the cylinder displacement, its upper portion being filled with broken rocks laid on a wide grating. These rocks should be well hosed down at regular intervals to wash off the dirt from the exhaust, water and all being carried away by a drain in the bottom of the chamber.

A separate exhaust pipe should be led to the well from each engine in a plant. If it is necessary to connect two or more units to one exhaust main, a shut-off valve should be fitted to each branch, and connections must be made with Y-pieces.

CHAPTER XXVI.

THE AUTOMOBILE.

373. **Types of Automobiles.** The term *automobile,* or its equivalent, *motor-car,* is somewhat loosely applied, but may be considered as signifying a self-propelled vehicle designed to run upon ordinary roads, and transporting passengers and commodities beyond those necessary for its own guidance or consumption. Two important exceptions are made from this classification: small vehicles, with two, three or four wheels, built along the lines of a bicycle, are separately classed as motor cycles, tri-cars or quads; various machines, such as road-rollers, traction engines, and the like, are also considered as being in a different category, although heavy slow-moving vehicles intended solely for the transport of merchandise are classified as heavy motor-cars or motor-trucks.

374. **Power for Automobiles.** The three chief sources of power, applicable to the propulsion of automobiles, are electricity, steam, and the light oils of petroleum.

Electricity is handicapped by the excessive weight of the accumulators necessary to develop a small power, and the need of recharging them at short intervals, this is due to the employment of lead and lead oxides as the chief constituents of the storage batteries. Still, for private use, more especially within cities, where the distances traversed are short and the proportion of stoppages large as compared with time in motion, the electric vehicle is largely the favorite on account of its silence, cleanliness and freedom from odor.

Steam has found great favor on account of the easy management of the working fluid, the absence of spur-gearing, freedom from ignition troubles, and the reduced cost of repairs due to lessened vibration. These advantages are counterbalanced by the extra care necessitated by a boiler and the cost of fuel, which most usually is some petroleum product whose efficiency is far less when burned under a boiler than when consumed directly within an internal combustion engine. Steam has its most effective application in heavy mercantile vehicles, where small tare weight is not a matter of great importance, and coke or anthracite may be used for fuel, which is fed into a generator that is a sort of combined water-tube boiler and gas producer.

The majority of self-propelled vehicles, for all purposes, save those previously indicated, are driven by explosion engines using petroleum spirit or light, volatile, hydrocarbons as fuel. The general arrangement of parts and nature of details are, broadly speaking, the same as previously described in Chapter XX. The engines of motor vehicles work almost invariably upon the Otto or four-cycle principle, weight being kept down by adopting a high speed of revolution, together with the use of specially strong steels and bronzes to insure light construction. The electric spark is universally employed as the means of ignition. A section of a typical motor is given in *Fig.* 147.

375. **Fuel for Motor Cars.** Crude petroleum varies in its constitution and consequently in its specific gravity, according to the locality of its origin, varying from 0.790 to 1.010. It is a highly complex mixture of many more or less volatile hydrocarbons, principally paraffins with some olefines. The oil is distilled in fractions, which are separated according to their boiling points. The most volatile part boils at from 113° Fahr.

to 138°, this is known as *petroleum ether;* the next product, boiling from 140° to 158° Fahr., is termed *gasoline*; *benzine* comes over from 160° to 200° Fahr., and is followed by various

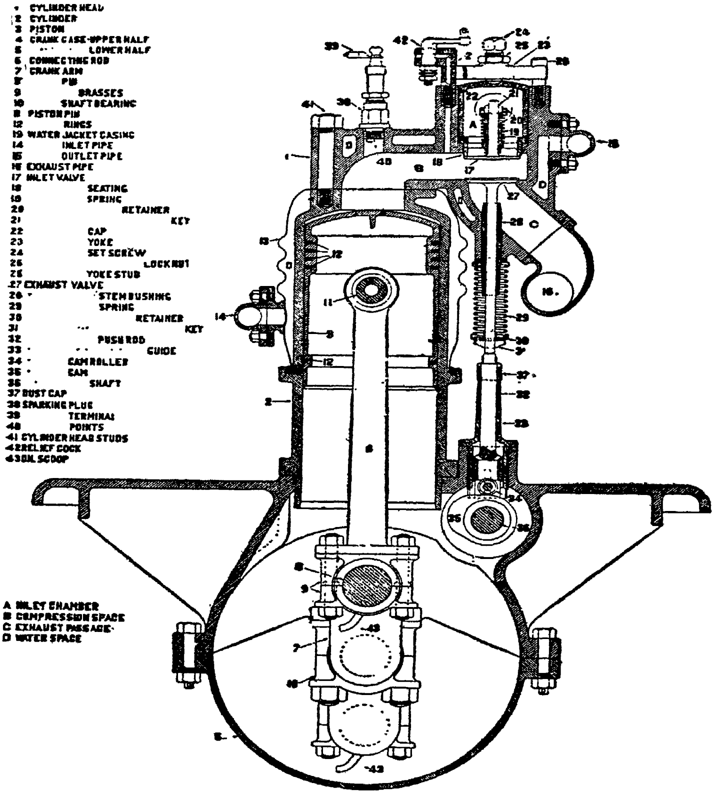

Fig. 147.—Section of Typical Automobile Motor.
(Paragraph 374)

naphthas, evaporating at points ranging from 200° to 300° Fahr. The foregoing are all combined to make American commercial gasoline, various fractional distillates being taken at intermediate points for such substances as benzoline, naphtha, etc. *Kerosene* or *illuminating oil* is boiled over at a range from 300° to 500°, the extent of the cut depending upon the quality of oil demanded; this is followed by *gas-oil* or *solar oil,* used for gas enrichment. The residuum is variously treated according to the products desired; lubricating oils, vaseline and paraffin wax are obtained from certain oils, which are distilled down to a solid coke, others may yield lubricants and then a tar; while some may be burnt as fuel without further treatment. No two petroleums are alike, East Indian kerosene weighing the same as Pennsylvanian residue, and each demands its own special processes of distillation and refining.

The more volatile products, known commercially as gasoline or benzine, are redistilled, usually by steam heat, to obtain separate qualities; these as well as the kerosenes are agitated with sulphuric acid to remove carbon particles or other impurities which tend to impair the qualities or color of the oil; next, the various products are treated with soda to neutralize free acid, and repeatedly washed. This constitutes the refining process.

The term *petrol,* as applied to automobile fuel, is in general use in England and upon the Continent. Petrol was a moderately heavy benzine, the first available fuel put on the French market, but the term has been extended to cover all light petroleum products, much in the same way as the American usage of the term *gasoline* has widened to include all the light volatile hydrocarbons known to refiners the world over as *benzine.*

376. **Classification of Vehicles.** Automobiles are generally classified according to their size and the character of the accommodation provided by the carriage body. Roughly speaking, for passenger cars, the classes are:—

Runabouts; small cars usually carrying only two persons.

Light Cars; of moderate power, ordinarily built to accommodate four persons.

Touring Cars; long distance vehicles, carrying from four to six, or more, with provisions for an extended trip.

Broughams,
Landaulets,
Omnibuses, } Arranged according to the practice in horse-drawn vehicles, as the name would suggest.

Many other types appear from time to time, chiefly differing in the arrangement of the seats or in protection against the weather. A well-known class is the *Limousine,* in which the rear seats are enclosed within a carriage body, the front or driver's seat being protected by a canopy only, or perhaps a glass screen.

377. **Essential Elements of an Automobile.** While in this age of the world it is impossible to assert that any device is perfected or that any has reached a finality, it is admissible to assume, for practical purposes, that recognized standards of construction are permanent. The essential features will be taken up in turn, therefore, describing their construction and explaining their uses. These may be summed, as follows:

1. The power developed by a motor carried on the running gear is applied to the rear wheels, or to a rotating shaft upon which they are secured.

2. The two driven wheels must be so arranged as to rotate separately, or at different speeds, as in turning corners. For

this reason, the compensation or differential gear is an essential element.

3. The two forward or steering wheels, studded to pivots at either end of a rigid axle-tree, must be arranged to assume different angles in the act of turning, in order that the steering may be positive and certain.

4. The body of the vehicle must be set relatively low, or the wheel-base, the length between forward and rear wheel-centers, must be relatively long, in order to obtain the best effects in traction, steering and safety.

5. The springs must be of such strength and flexibility as to neutralize vibration, absorb jars and compensate any unevenness in the roadway.

6. The distance between the motor and the driven wheels must be bridged by adjustable radius or reach-rods in order that the drive may not be interrupted by the vibrations of travel.

7. The wheels must be shod with pneumatic, or other forms of tires of sufficient resiliency to protect the machinery, running gear and passengers, from jars and shocks otherwise inevitable at high speeds on ordinary highways.

8. Positive and powerful brakes must be provided, in order to secure effective checking of motion, whenever required.

9. All parts must move with as little friction as possible, in order to save power for traction. For this reason, ball or roller bearings are generally used on all rotating shafts of motor carriages.

10. Convenient and efficient means for ready and liberal lubrication of moving parts is a constant necessity.

11. Balance of parts and stable construction are required to reduce wear and friction.

12. Simplicity of structure and ease of handling and repair are the prime requisites of the best automobile.

13. All working parts must be of sufficient size, weight and strength to endure the jars of travel, and be serviceable under all conditions. There may be some advantages in the light construction, formerly supposed to be essential, but present-day practice recognizes the evident fact that strength and durability are more important considerations.

378. **Driving Parts of an Automobile.** A sectional elevation of a 50-horse-power, four-cylinder car is given in *Fig.* 148, a plan of the same car being shown in *Fig.* 149.

The lower part of the car is known as the *chassis;* this term includes the framing, the supporting wheels, the propelling machinery and transmission gear, the steering mechanism, etc. Except with heavy motor vehicles, it is customary to build the various chassis, for the same power of engines, of uniform dimensions, the various types of body being fitted to similar chassis according to the desires of the purchaser.

The essential propelling elements of an automobile, using petroleum spirit, are as follows:—

1. The fuel tank, containing a supply of gasoline, petrol or other variety of petroleum product.

2. The *Vaporizer* or *Carburetter,* in which the liquid fuel is vaporized or atomized and mixed with air to form an explosive mixture.

3. The *Engine* or *Motor,* in which the explosive mixture or charge, drawn from the carburetter, is compressed, ignited, expanded and the burnt gases expelled; by which process as much as possible of the available heat of the fuel is converted into power for driving the vehicle.

4. The *Radiator* or *Cooler,* subsidiary to the engine, an arrangement of cells or tubes with projecting fins or webs,

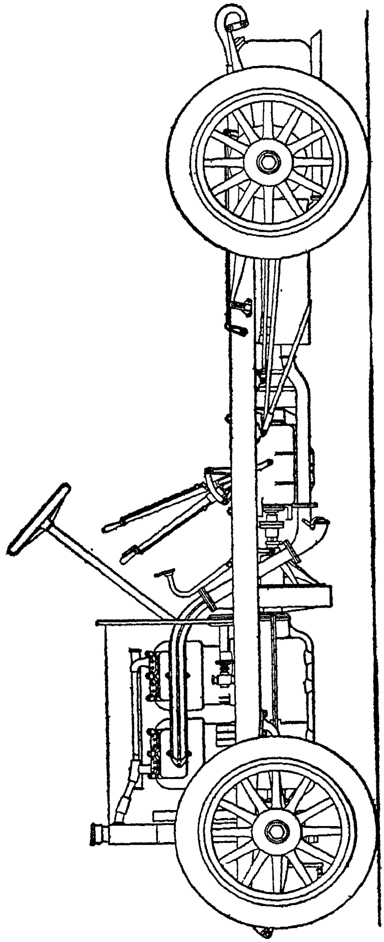

FIG.—148.—FOUR-CYLINDER AUTOMOBILE CHASSIS; 50-HORSE-POWER. (Paragraph 378.)

wherein the cooling water for the cylinder jackets is reduced in temperature, by exposing as large a surface to the air as

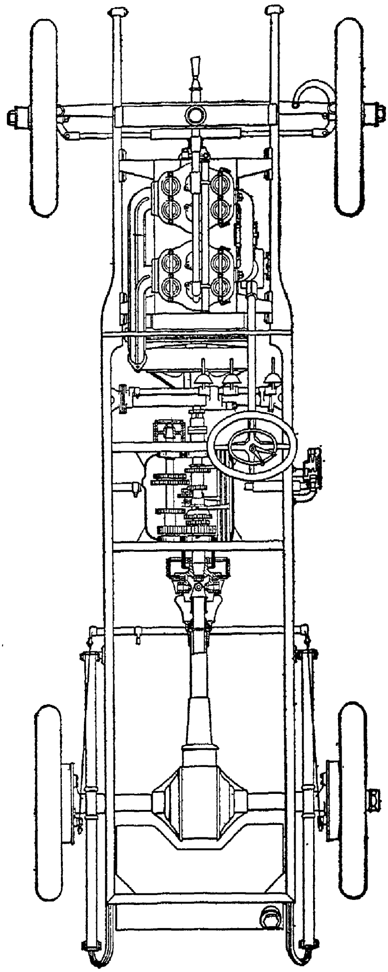

FIG. 149.—PLAN OF 50 HORSE-POWER CHASSIS.
(Paragraph 378)

possible; this dissipates the waste heat of combustion by the effects of radiation. Some engines are air-cooled, that is, the cylinders are provided with deep fins or projecting spines to expose a large area to the air driven among them by a fan and the progress of the car.

5. The *Muffler* or *Exhaust Silencer,* whereby the products of combustion are discharged into the atmosphere. This is a chambered and partitioned vessel, wherein, by gradual expansion of the gases, the noise of the explosion is lessened.

6. The *Clutch,* by means of which the employment of the power is controlled, the engine, which revolves whether the car is running or not, being connected at will with the transmission gearing, or disengaged therefrom.

7. The *Change Speed Gear,* by means of which the relations between the speeds of the driving and driven mechanism may be varied to suit the gradient on which the car travels, the same gearing also provides means for reversing the motion of the car.

8. The *Transmission Gearing,* which transmits the power of the engine to the driving wheels, either through bevel or spur gearing, or by means of chains traveling on sprocket wheels.

9. The *Tires,* generally pneumatic, or inflated with air, in order to be able to move at high speeds without excessive vibration and wear and tear in the working parts.

The propulsion elements of a steam car are in some measure identical. Owing to the possibility of stopping the motor while the car is stationary, the clutch is dispensed with in these cars; and, as the steam answers to throttling, a change speed gear is unnecessary. The condenser takes the place of the radiator, leaving the boiler additional, its weight being to some extent counterbalanced by the absence of change and clutch gear.

379. Description of Details. The usual form of carburetter is of the "spray" type, the fuel being atomized from a jet or nozzle, mixed in that state with the air supply; the flow of the liquid is regulated by means of a cork or hollow metal float within a chamber of the carburetter (See par. 232, 233 and *Figs.* 110, 111.)

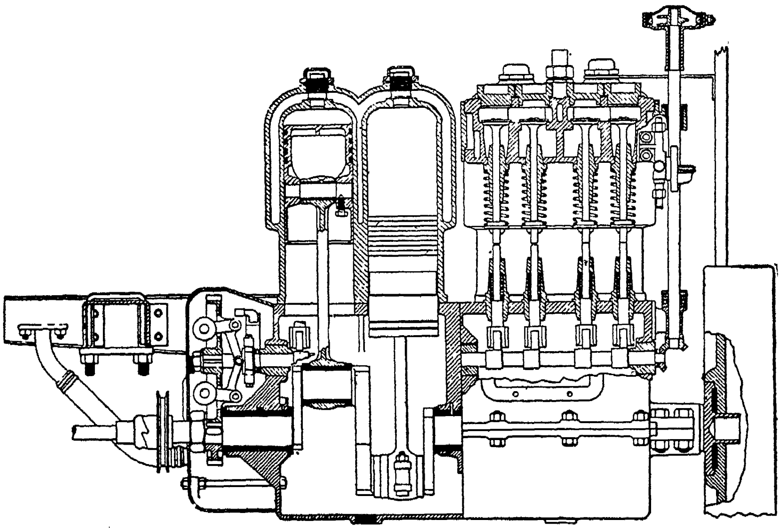

FIG. 150.—PART SECTIONAL ELEVATION OF THE PACKARD FOUR-CYLINDER ENGINE. Showing method of driving the inlet and exhaust valves from a single cam shaft. (Paragraph 379.)

As already stated the gasoline motor, commonly employed, works upon the Beau de Rochas or Otto cycle, receiving an impulse on each piston, during each fourth stroke. The number of cylinders in general use ranges from one, in small cars, to six or more in the better class of touring car or high-powered machines specially built for racing purposes. As has been shown in paragraph 145, the employment of a multicylinder engine produces more uniform turning effort, lessens vibration

by counterbalancing disturbing forces, and permits smaller parts through splitting up the power between a number of cylinders.

A section of a four-cylinder engine is given in *Fig.* 150, which will be seen to be a compact arrangement similar to other engines illustrated. The cylinders are usually cast in pairs, as shown, together with their pedestal or standard, which is bolted direct on the sole-plate of the engine. The crank pins are placed in pairs opposing each other; thus, in a four-cylinder car two pistons would be at the top center and two at the bottom; in a six-cylinder engine the cranks would be arranged in pairs 120° apart. The former arrangement gives two impulses at each revolution, the latter providing three. It will be observed that the valve gear illustrated is the same as that previously shown on a larger scale in *Fig.* 45.

Radiators or coolers are of quite varied designs, the object in each case being to expose as large a surface as possible to the air. The water is carried in a tank slung near the rear or driving axle, is forced by means of a small centrifugal pump through the water jackets, passes to the radiator and returns to the supply tank once more. Fans or propellers, belt driven from the crank shaft, are frequently employed to assist the radiator, drawing air through it from forward, and discharging over the outside cylinder casing, thus keeping down the temperature inside the bonnet.

Air-cooled cylinders have been successfully tried, the radiating surface being provided by gills or ribs on the cylinders, or by solid or tubular spines screwed radially into the outer cylinder wall. A fan is indispensable in this connection.

Clutches are made of different designs, some constricting around the other part to effect engagement, while others expand

for the same purpose. Some type of rigid cone is usually employed, effecting engagement or disconnection at will between the intermediate shaft and the fly wheel of the engine. Clutches of this type are shown in *Figs.* 151 and 152, the working sur-

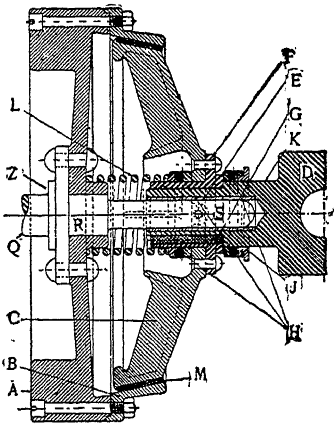

FIG. 151.

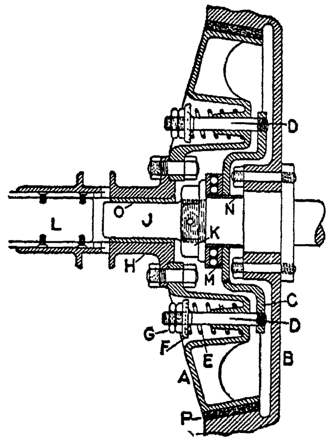

FIG. 152.

FIG. 151.—INTERNAL CONE CLUTCH OF THE PEERLESS CAR.

A, engine fly-wheel; B, female cone; C, male cone; D, universal coupling on male cone; E, bushing on D; F, collar keyed on D; G, key; H, ball bearings for taking up the thrust on disengaging clutch; J, flange on ball cone; K, receptacle on D for operating yoke; L, spiral spring for retaining clutch surface contact; M, leather band riveted on C, giving good friction surface; Q, main shaft; R, portion of shaft turned down to fit fly-wheel; S, portion of shaft turned down to receive clutch sleeve; Z, flange to which fly-wheel is bolted.

FIG. 152.—EXTERNAL CONE CLUTCH OF THE POPE-TOLEDO CAR.

A, fly-wheel clutch cone; B, fly-wheel; C, fly-wheel clutch stud plate; D, D, clutch spring studs; E, clutch spring; F, spring retainer; G, retainer lock nut; H, sliding sleeve for setting clutch; J, crank shaft end; K, crank shaft nut; L, tail shaft; M, ball thrust collar; N, ball thrust bush; O, sliding sleeve bush; P, clutch cone leather.

(Paragraph 379)

faces being leather-faced. An advance on this type is found in metal to metal contacts with either coil clutches, or cones with multiple discs not unlike the Weston triplex pulley blocks.

The most commonly employed change-speed gear consists of toothed wheels, a series of spur wheels, of different diameters, on a sliding sleeve being successively moved along the shaft to

mesh with wheels of another series mounted on the driven shaft. A well-known type of transmission, as shown in the accompanying section, *Fig.* 153, consists essentially of two parallel shafts. Of these, the countershaft carries four-keyed spur-wheels, D, E, F, G, the largest of which, D, is constantly in mesh, with pinion, A, on the clutch shaft. The clutch shaft, however, terminates with this constantly-meshed wheel, being bored longitudinally, so as to afford a bearing at L, for one end

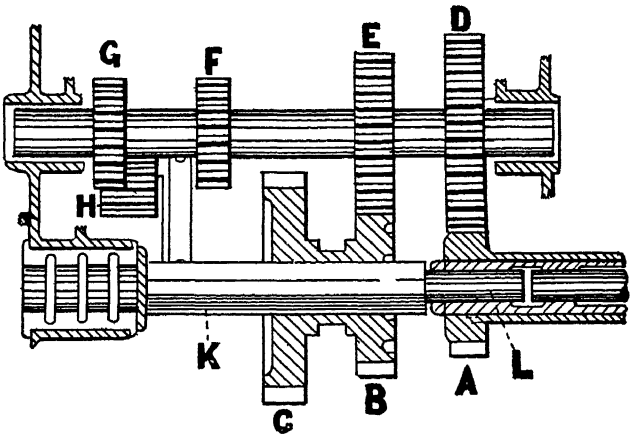

FIG. 153.—DIAGRAM OF THE DECAUVILLE TRANSMISSION GEAR.
A, is the spur pinion at the end of the clutch shaft; B and C, spurs on the sliding sleeve; D, E, F, G, spurs keyed to the second motion shaft; H, the reverse pinion, constantly in mesh with G, and giving the reverse when in mesh with C also; K, the square portion of the drive shaft; L, portion of same journaled into the clutch shaft.
(Paragraph 379)

of a second shaft, K, arranged continuous with it, but turning separately. The entire length of this second shaft, between bearings, is of square section, so that the double-faced gear wheel B C, may be slid from end to end by means of a fork set at one end of the gear-shifting lever.

When the double wheel is moved to the left, so that the pinion, F, on the countershaft meshes with the larger of the

two, C, on the square shaft, the low speed forward is obtained. By sliding the sleeve to the right, so as to bring the larger wheel, E, on the countershaft into mesh with the smaller one, B, on the square shaft, the second speed is obtained. By sliding the sleeve all the way to the right, so that, by a form of claw clutch its right-hand gear, B, grips the pinion, A, on the clutch shaft, the highest forward speed is obtained, the drive being then con-

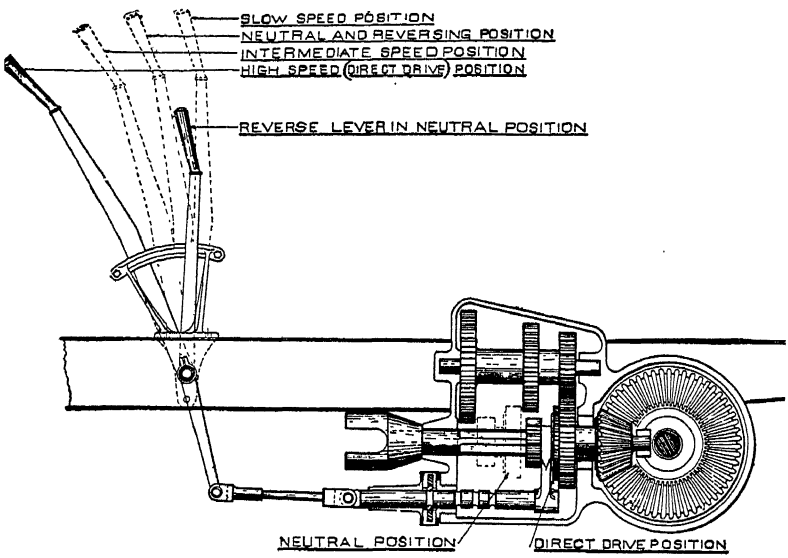

FIG. 154.—DIAGRAM OF CONTROL LEVERS AND TRANSMISSION OF THE PACKARD CAR. (Paragraph 379)

tinuous from the motor to the road wheels: this last constitutes what is known as a *direct drive*. The reverse is obtained when the sliding sleeve double wheels are moved all the way to the left so that the larger of the two, C, meshes with an idler pinion, H, constantly driven from the end gear, G, of the countershaft, by which means the rotation of the square shaft and of the road wheels is reversed.

Another popular form of change-speed or transmission gear is the "Sun and Planet" or epicyclic change gear. In this several small pinions rotate around a larger spur-wheel with which they are continually in mesh. The use of this type of gear is increasing.

A sectional elevation of a sliding change-speed gear is given in *Fig.* 154, showing the different lever positions required for various movements. It will be noticed, in this case, that power is transmitted from the motor, through the clutch, to the transmission gear by means of a shaft connected with universal joints, while the gear itself is close up against the rear or driving axle, which is rotated by means of bevel wheels.

When the lever is farthest forward, the small pinion on the square shaft is in gear with the largest on the countershaft, giving the slowest speed; the next step throws the forward gear out of mesh into a neutral position; another backward pull of the lever engages the larger wheel on the square shaft with the smaller wheel on the countershaft, giving an intermediate speed. Direct drive for top speed is effected by using the sliding wheels as a jaw-clutch, as illustrated, causing its teeth or projections to engage with other projections upon the short shaft to which the bevel pinion is keyed. Reversal is effected by placing the forward lever in the neutral position and then bringing an idle pinion, not shown, into mesh with the small wheel on the square driving shaft and the large one on the top or counter shaft; this is performed by means of the reverse lever operating a bell-crank. It will be noticed that the two gear wheels to the right are constantly in mesh with each other.

There are three chief methods of power transmission in general use: 1, the *parallel drive,* in which the motor shaft, countershaft and driving axle are parallel to each other, the motion

being transmitted directly through spur gearing or by means of chains; 2, the *Panhard* or *Continental drive,* in which the motor, whose shaft is longitudinal to the car, drives through a clutch to the change-speed gearing, and thence by bevel wheels to a sprocket countershaft, which by means of two side chains applies power to the rear wheels; 3, the *longitudinal shaft drive,* where the engine and change-speed gear are arranged as in the Panhard, but the bevel gearing is situated on the rear driving axle, the transmission being effected by a longitudinal shaft with universal joints at either end; this latter method is often termed the *propeller shaft drive.*

Many early cars were belt driven, but, owing to their being much affected by changes in the weather, the use of belts has been practically abandoned.

The wheels of a motor car are usually of the "artillery" pattern, that is, shaped like those of gun-carriages, the spokes all wedging together at the nave or hub. Except in very heavy cars, some form of rubber tire is universally fitted to the wheels; commercial vehicles having solid tires or else those of the cushion type, which has a thick tubular section; while pneumatic tires, pumped up to a pressure of from 75 to 100 lbs. per sq. in., are supplied to most passenger automobiles. To avoid side-slip or *skidding,* metallic studs or corrugations are often fitted to the pneumatic tires, while steel chains and leather bandages are frequently furnished for the same purpose.

The axles of an automobile are generally *dead,* that is prevented from rotation, the wheels revolving freely on their tapered ends; where the shaft drive is employed, however, a *live* rear axle is fitted, it being driven by a bevel gearing at its middle portion. In such a drive it is necessary to have a differential arrangement so that the outer wheel may revolve faster than the inner when rounding a curve.

The short axle-ends of the front wheels are hinged on the forward axle; these two pieces are connected together by a system of linkage, which provides for steering the car by slewing the front or steering wheels towards either hand. The movement of the steering gear is effected by a large hand wheel.

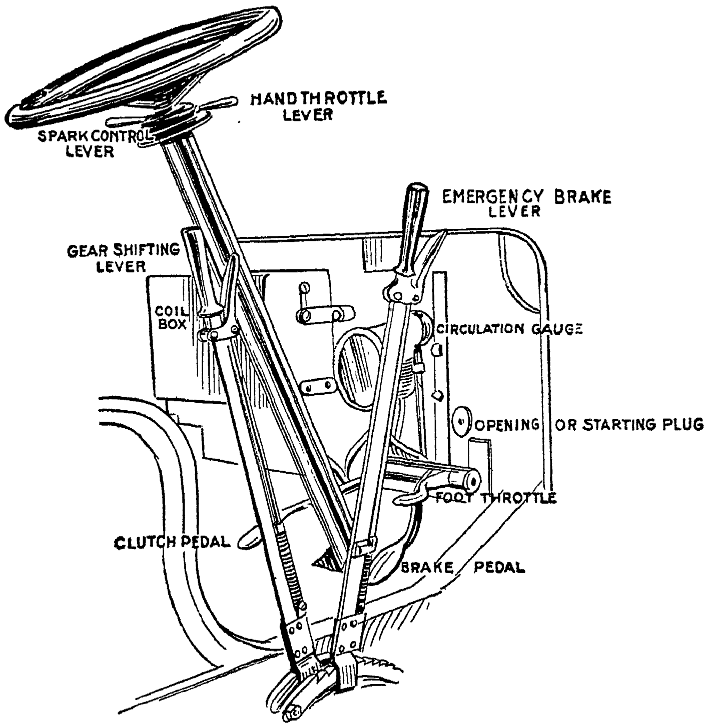

FIG. 155.—CONTROL LEVERS AND APPLIANCES OF A MOTOR CAR (Paragraph 379)

Brakes are usually of a band or constricting type acting upon drums or pulleys on the driving axle, or work on the expansion principle, shoes being thrust outwards against the inner circumference of a cone or flanged disc. A plain band brake is

ineffective on a motor car as it will not act should the car begin to run backwards on a steep gradient; it is necessary to use two shoes, one on either side of the drum, or to have each end of the brake band attached to an arm upon the lever rock-shaft, thus applying the braking force in either direction.

A study of the illustrations given in *Figs.* 148 and 149, will show the arrangement and appearance of the parts just enumerated, and also the manner in which the controlling devices are located in convenient positions.

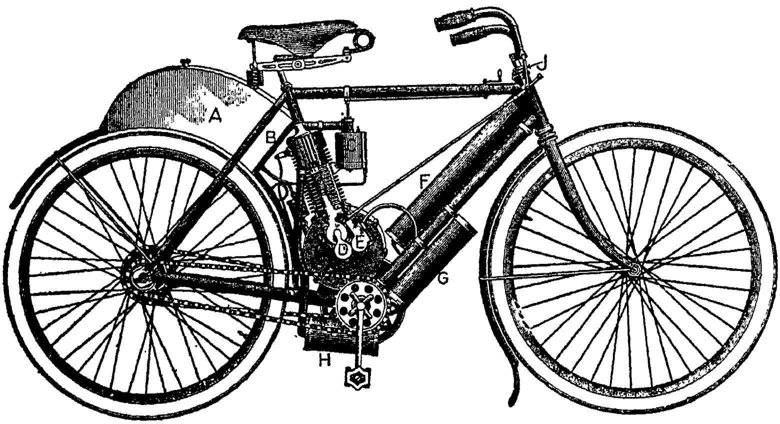

FIG. 156.—AMERICAN MOTOR BICYCLE.

A.—Gasoline Tank.
B.—Lubricating Oil Tank.
C.—Carburetter.
D.—Valve Gear Case.
E.—Primary Circuit Breaker.
F.—Battery.
G.—Induction Coil.
H.—Exhaust Muffler.
J.—Grip Control Lever.

(Paragraph 380)

The spark control and throttling levers are carried on the steering-wheel, an extra throttling device being afforded by a pedal, it being possible by these means, to vary the speed of the motor illustrated from 300 to 1,300 revolutions per minute. The friction clutch may be thrown out of gear, when desired, by means of the pedal shown in the elevation view, while a third pedal applies the brakes. The two vertical levers shown,

control, respectively, the emergency brake, and the change-speed gear; the inner lever, which actuates the latter being moved into one or another of the recesses in the quadrant according to the rate of speed desired.

The sight feed lubricator, gauges, spark coil and other details are attached to the dashboard immediately in front of the driver's seat, as will be better seen in *Fig.* 155, which illustrates the neat arrangement of the controlling levers, etc., on a good-class car.

380. **Motor-Cycles.** Reference has already been made to motor-cycles; a representative motor bicycle is illustrated in *Fig.* 156.

The framing is but little different from that of an ordinary bicycle, the air-cooled motor being slung within the frame; this varies usually from 1¾ to 2½ horse-power, but expert riders, more especially in hilly country, use motors of 3½ to 5 horse-power or more. The weight of a 2½ h. p. machine is 75 to 80 lbs., a 6 h. p. cycle weighing 160 lbs.

The model illustrated drives through gearing and a sprocket-chain on to the rear wheel; in this case, braking can generally be effected only by the compression within the cylinder. A better and more general method is the direct drive from the motor shaft by means of a leather or raw-hide belt on to a separate rim upon the driving wheel; an effective foot brake is fitted which is applied to this rim.

It is scarcely necessary to add that the bicycle is of the free wheel type; the rider uses the pedals in starting or in ascending a steep hill, but not at other times.

The various levers for regulating the fuel supply, for controlling the spark, for throttling, or for lifting the exhaust valve

at starting, are all disposed conveniently around near the handle-bars. A rim brake is frequently fitted, bearing on the inside of the rim of the front wheel. Thin tanks are conveniently disposed behind the rider, or between his legs, containing the supplies of fuel and lubricating oil; the gasoline feeds into the carburetter by gravity.

Jump spark ignition is almost exclusively used, and the higher-powered machines are fitted with high tension magnetos.

Six to eight horse-power motors, with two, three, or even four cylinders are employed with tri-cars and quadricycles, but they are generally water cooled and a change speed gear is employed.

The motor bicycle is generally sufficiently powerful to carry a heavier load than its rider, the accommodation for an extra passenger being attached in various ways, either on a seat, supported by one wheel, which is secured abreast of the rider, or in a two-wheeled seat which replaces the front wheel.

This last constitutes the general design of the *tri-car* previously referred to.

The great difficulty of the motor cycle is vibration; this is sought to be nullified by larger saddles with coiled-spring supports or spring pillars; also by double forks to the handle-bars, saving jar to the wrists, and the like.

The general tendency is to build motor cycles without pedals, this being more apparent in the tri-cars and quads, which latter approximate usually to small motor-cars.

CHAPTER XXVII.

USEFUL RULES AND TABLES.

381. Weight of Coal and Coke in Pounds per Cubic Foot:—

In addition to the Rules and Tables given in the body of this work, the following are introduced herein for convenient reference (see Index):

Anthracite Coal,	market sizes, loose	52-56;
"	market sizes, moderately shaken	56-60;
"	market sizes, heaped bushel, loose	77-83;
Bituminous Coal,	broken, loose	47-52;
"	moderately shaken	51-56;
"	heaped bushel	70-78;
Dry Coke		23-32;
"	heaped bushel (average 38)	35-42.

Standard Bushel, American Gas Light Association: 18½ inches diameter, and 8 inches deep = 2150.42 cubic inches.

A heaped bushel is the same plus a cone 19½ inches diameter and 6 inches high, or a total of 2747.7 cubic inches.

An ordinary heaped bushel = 1¼ struck bushels = 2688. cubic inches = 10 gallons dry measure.

Crude Petroleum = 7.3 pounds per U. S. gallon.

382. Melting Points of Metals:—

	Centigrade	Fahrenheit
Sulphur	115°	239°
Tin	230	446
Lead	326	618
Zinc	415	779
Aluminum	625	1157
Silver	945	1733

Gold	1045	1913
Copper	1054	1929
Cast Iron, white.......	1135	2075
" gray	1220	2228
Steel, hard	1410	2570
" mild	1475	2687
Palladium	1500	2732
Platinum	1775	3227

383. **Heat Units:—**

A French Calorie = 1 Kilogram of H_2O heated 1° C., at or near 4° C.

A British Thermal Unit (B. T. U.) = 1 pound of H_2O heated 1° Fahr., at or near 39° Fahr.

A Pound-Calorie Unit = 1 pound of H_2O heated 1° C., at or near 4° C.

1 French Calorie = 3.968 B. T. U. = 2.2046 Pound Calories.

1 British Thermal Unit = .252 French Calories = .555 Pound Calories.

1 Pound-Calorie = 1.8 B. T. U. = .45 French Calories.

1 B. T. U. = 778 foot-pounds = Joule's mechanical equivalent of heat.

1 Horse-power (H. P.) = 33,000 foot-pounds per minute.

$$1 \text{ Horse-power} = \frac{33{,}000}{778} = 42.42 \text{ B. T. U. per minute.}$$

$$1 \text{ Horse-power} = 42.42 \times 60 = 2545 \text{ B. T. U. per hour.}$$

384. **Calculation of Diameters of Pipe.** In using the following formula, ample allowance should be made for the effect of temperature.

Where **d** = diameter of pipe in inches; **Q** = quantity of gas in cubic feet per hour; **l** = length of pipe in yards; **s** = specific gravity of gas, air being 1; **h** = head or pressure in inches of water.

$$d = \sqrt[5]{\frac{Q^2 \, s \, l}{(1350)^2 \, h}}$$

The volume of a gas varies as its absolute temperature, which is the ordinary temperature + 273° C. or + 461° Fahr. See Paragraph 13.

385. **Equivalent Heating Values for Gas, Fuel Oil, and Coal.** Equivalent values for natural gas and coal vary considerably on account of variations in their quality, and differences in practice, but approximately—

35,000 cubic feet of natural gas = in heating value, 1 ton of coal, and—

1 pound of fuel oil = 1.45 pounds of coal.

386. **Conversion of English into Metric Weights and Measures** may readily be made by the use of the following Constants—

Length: 1 inch = 0.0254 meter.
1 foot = 12 inches = 0.3048 meter.
3.281 feet = 39.37 inches = 1 meter.

Volume: 1 U. S. gallon = 0.16057 cubic foot = 4.537 liters.
1 cubic foot = 0.02832 cubic meters = 2.83 liters.
35.32 cu. ft. = 220 U. S. gals. = 1 cu. meter = 1000 liters.

Weight: 1 lb. = 16 ozs. = 7000 grains = 0.4536 kilogram.
2.2046 lbs. = 1 kilog. = 1 liter of water at 4° C.
0.9842 ton = 1 ton = 1000 kilogrammes (kilos).

Pressure: 1 lb. per sq. in. = 0.0703 kilog. per sq. cm.
1 atmosphere = 14.7 lbs. per sq. in. = 1.0333 kilog per sq. cm.
14.223 lbs. per sq. in. = 1 kilog. per sq. cm.

Work: 1 foot-pound = 0.13825 kilogrammeter.
7.233 ft. lbs. = 1 kilogrammeter.

Power: 1 horse-power = 1.01385 force de cheval.
0.9863 H. P. = 1 force de cheval = 75 kilogrammeters per second.
1 watt = 0.00134 H. P. = 0.1019 kilogrammeter per second.

387. **Rules for Calculating Power Required.** To compute the horse-power required to raise a given quantity of water to a certain height, multiply the gallons per minute by 8.35, and multiply this product by the height in feet; the result will be the power required in foot-pounds. To reduce this to horse-power per minute divide by 33,000. Usually, an allowance of 50 per cent. is made for friction and other loss.

To estimate the horse-power required to deliver an electric load, multiply the amperes by the voltage, the product will be the total number of watts. An electrical horse-power is 746 watts, therefore, divide the total number of watts by 746 and the result will be the electrical horse-power. To ascertain the brake horse-power of the engine when direct connected to generator, multiply the amperes by the voltage and divide by 660; the result will be the approximate brake horse-power of the engine.

If the engine is of the belted type, divide the total number of watts by 550 instead of 660.

In computing the horse-power it is customary to allow ten 16 candle-power lights to the horse-power. A 16-candle-power light is equal to 55 watts.

388. Rules for Determining the Size and Speed of Pulleys and Gears. The pulley from which the belt runs is usually called the *driver*, and the one which it rotates is called the *driven*.

If the size of toothed wheels be required, the number of teeth must be used in the place of the diameter wherever the latter occurs in these rules.

To find the diameter of the driver, when the diameter of the driven and its revolutions, and also the revolutions of the driver are given; multiply the diameter of the driven by its revolutions and divide the product by the revolutions of the driver.

To find the diameter of the driven, when the revolutions of the driven, and the diameter and revolutions of the driver are given; multiply the diameter of the driver by its revolutions and divide the product by the revolutions of the driven.

To find the revolutions of the driver, when the diameter and revolutions of the driven, and the diameter of the driver are given; multiply the diameter of the driven by its revolutions and divide the product by the diameter of the driver.

To find the revolutions of the driven, when the diameter and revolutions of the driver, and the diameter of the driven are given; multiply the diameter of the driver by its revolutions and divide the product by the diameter of the driven.

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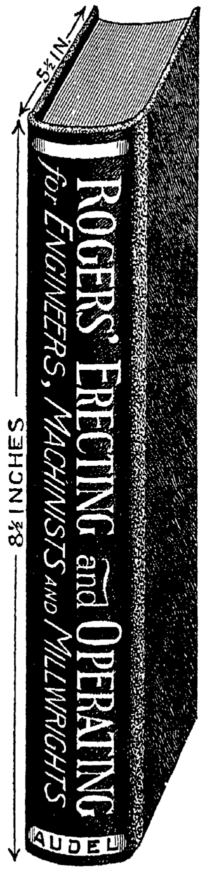

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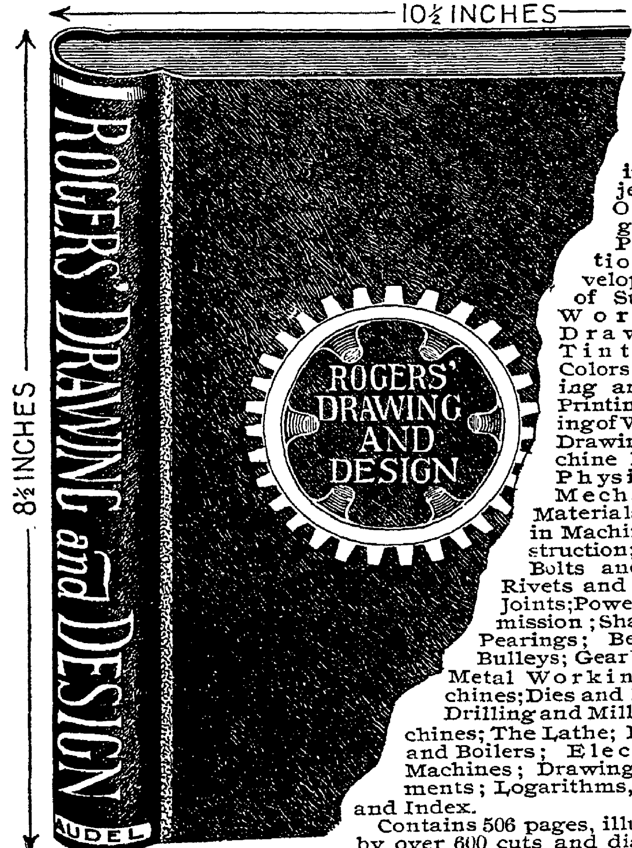

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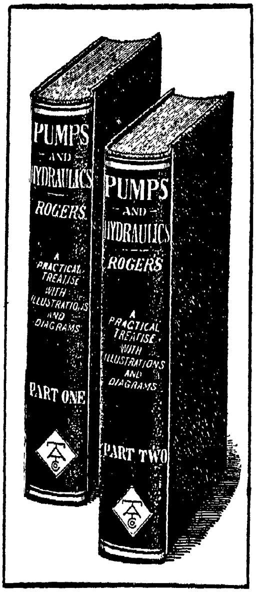

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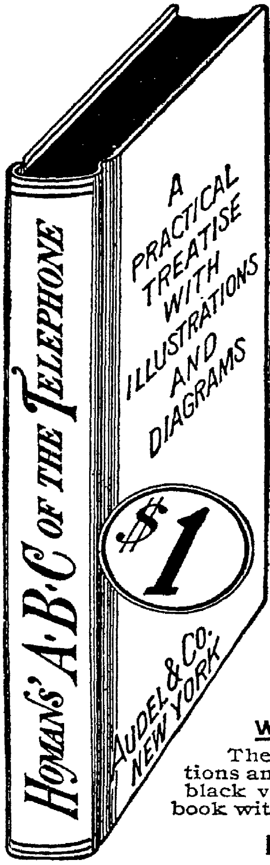

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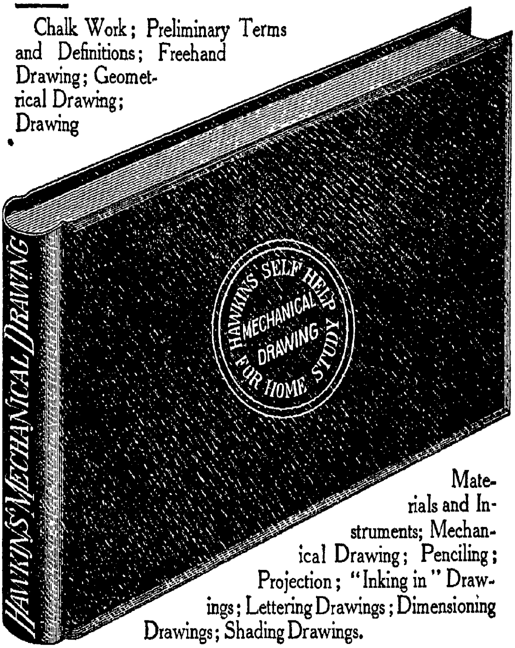

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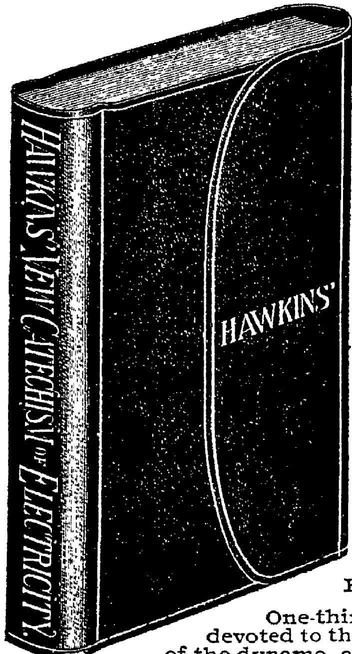

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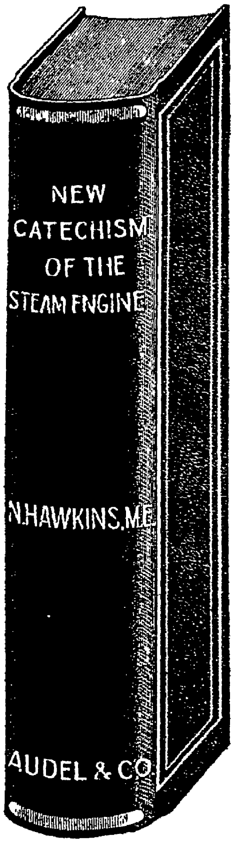

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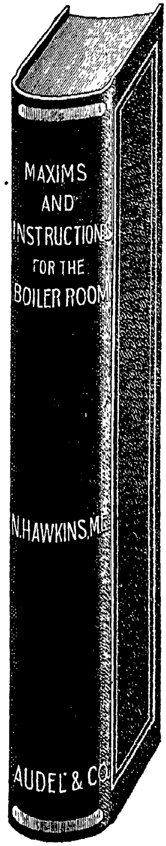

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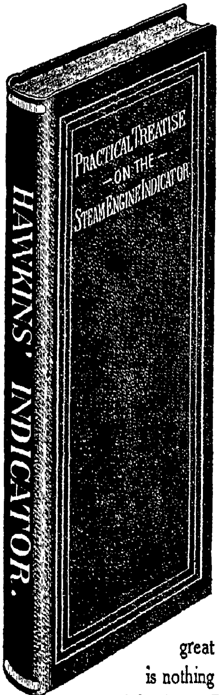

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